REFINER
AND NATURAL GASOLINE MANUFACTURER

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GEORGE REID
Editor

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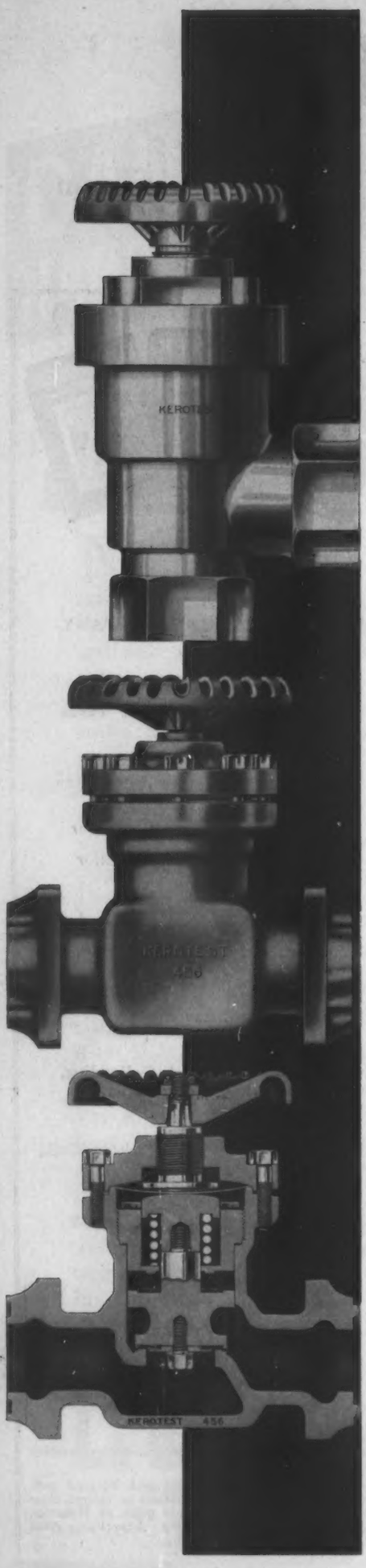

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VOLUME 14, No. 3 MARCH, 1935

REFINER
AND NATURAL GASOLINE MANUFACTURER

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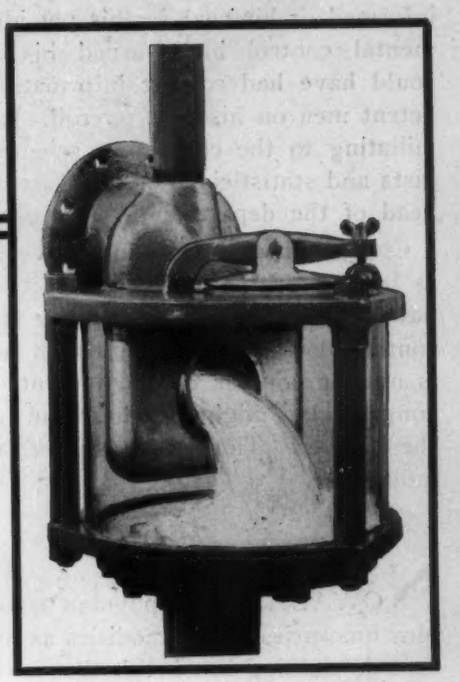
The Look Box



PROPANE, and its close relatives, all valuable tools available to the refiner, is well on its way toward reaching that importance justified by its properties, characteristics and utility.

Propane

Preceded by "petroleum ether" in the laboratory where for a long time it has been used in the separation of asphalt, and thus pointing to a commercial process that lay overlooked for years, the lighter hydrocarbons now of such growing importance may well form the principle method by which many types of lubricating oil will be manufactured.

Technical thought differs, as is usual. There are those who state that a couple of years ago it appeared that propane dewaxing processes were the most important and with its need for propane, might drag de-asphaltizing along with it. The same technologists now assert that conditions have turned around and propane dewaxing will have to be salvaged by asphalt removal by use of propane. With and without other selective solvents or re-agents, propane will find its way in the manufacture of special asphalts, lubricating oils of special properties, and will even enter into the cracking operations.

In cracking, propane usage makes possible the segregation of carbonaceous materials or bitumins outside of the high temperature or cracking zone. Highly cracked refractory materials, for example, can be treated with propane and the carbon value shifted by the removal of same, giving a new and more favorable hydrogen relationship so that further cracking can be carried out, giving valuable quality cracked products. One suggested method is that the virgin or primary stock be lightly cracked and flashed, the overhead going to cracking and the heavy residuum passing to propane solvent treating where the carbon can be removed in solid form, possibly, and the extracted oil returned to the cracking zone.

Under such a method improved cracking conditions are made possible and a product possessing a higher hydrogen relationship or ratio may be charged to the cracking zone and the carbon or solid asphalt separated at lower temperatures, i.e., without heat, and kept out of the cracking zone entirely.

Other technologists think differently and progress continues. Technical and engineering development never stands still. And, it still holds, "An expert is one who can forget his old ideas and substitute new ones."

ANY KIND of permanent federal control of the oil industry has been made more remote by recent utterances of Mr. Ickes. He went to his own Bureau of Mines for pictures to illustrate his propaganda for federal regulation, and it is probable that he will regret that he did not also consult that department on facts. More than half of the members of the Congress come from oil producing states. They probably will hear from their constituents. Also the Congress itself

Federal Control

has been making some investigations through a committee that did its work conscientiously. What congressmen from oil states know of conditions within their states and what the committee report will show, is so greatly at variance with Mr. Ickes' statements that all of them must be convinced that Mr. Ickes is deliberately misinformed or his zeal for his pet idea of governmental control has warped his honesty. He could have had correct information from competent men on his own payroll. It must be humiliating to the competent scientists, technologists and statisticians of the Bureau to have the head of the department so expose himself.

Congressmen already do not see a lot of things as Ickes sees them. The prospect that he would have enlarged powers under any form of federal control blocks the proposition on two counts: he is neither popular nor competent. The average congressman might overlook the latter, but not the former. The two together appear insurmountable.

Science and Surpluses

NOWADAYS it is popular to look upon surplus quantities of commodities as industrial evils that do nothing but break the market, which in turn causes unemployment, etc. This is a short-sighted viewpoint. There have been hardships since times unknown, but always the knowledge and experience gained has permitted the inhabitants of the world to improve their position. Industrial depressions have the same influence on business.

Surpluses, while causing immediate distress, may really be blessings in disguise. Such conditions place pressure upon the ingenuity of mankind, urging him to perform the commendable enterprise of discovering new uses for the commodity, which once found add to our wealth and comfort.

There are experiments of far-reaching importance going on this minute. Recently, there has been developed a process whereby a gas, heretofore a by-product in the refining of gasoline, may be used for both the refrigerant and the motor fuel in truck service. Who knows but that this development of scientific research may open up a new field for the use of trucks that may be far beyond any present conception? Who can determine the ultimate outcome of the trend to use internal combustion engines as prime movers on railways? Who can forsee tomorrow's air traffic? Any one of a vast number of engineering and scientific developments may be the starting point for revolutionizing our industries and discarding our theory today about surpluses.

Scientific progress is just beginning. There will be more progress in this field in the next 25 years than we have ever witnessed, and each and every perfected process or product will provide more work for man and a greater demand for raw material.

Somehow, some day, good will be the final outcome and science is apt to be a far greater factor than our present day efforts to achieve commodity production control.

Purely Gossip

IF rumors are correct, several important mergers and sales will be consummated during the first six months of 1935. Some of these will be among the larger petroleum companies. Stanolind Oil & Gas Company, Yount-Lee Oil Company, Sun Oil Company, Consolidated Oil Corporation, Tide Water Oil Company and Simms Oil Company are mentioned in gossip talk as concerns figuring in possible mergers, or as purchasers or sellers. Although none of the transactions are consummated, some of the "wise ones" predict the chances are good for part of the deals going through.

Trained Men

"AS manager of refineries for my company let me state that if my key men did not subscribe to and read at least one technical journal, I believe I would revamp my organization." The quotation is from the conversation of one forward looking technically trained executive, who went even further and later stated that the trend toward the use of trained men in all positions of responsibility was accelerating and had reached the point where it is customary to employ chemical engineers as operators or foremen in charge of each still battery, or equivalent in processing facilities.

Key men in any refinery include superintendents, their assistants, foremen and chief operators or the like, also chemists, their assistants, research chemists and engineers and chief engineers and their assistants, and others. Nomenclature of positions of responsibility differs with virtually every refining company.

And the man at the receiving house, at the treaters, the compounding and blending plant, those in charge of stabilizers and gasoline recovery plants, the asphalt plant, the power plant and its power engineers, the grease plant, dewaxing, solvent refining or extraction and others of the numerous systems and processes used in processing petroleum—those in charge, whether for eight-hour shifts or 24, become key men, trained men, as a rule.

(Continued on page 39a

REFINING ENGINEERING PROGRESS 1935

Symposium—Part I

THE REFINER in this issue presents Part 1 of a symposium on Engineering Progress in Petroleum Refining. The second group of these important and timely articles will be presented in the April issue as Part 2 of the symposium. The articles have been prepared by a well known group of authorities in various fields and are directly applicable in their context to the technical and practical problems of today.

Part 1 of the symposium consists of articles dealing with metallurgy as it applies to refining equipment; technical progress during 1934 and what may be expected in 1935; the first of a valuable series of discussions on inspection of refinery equipment; the trend in natural gasoline manufacture; a new asphalt manufacturing process; a discussion of a process for removal of hydrogen sulphide from gases; Part 1 of a series on technical control of percolation filtration; a discussion of the trends in chemical refining; Part 1 of a series on methods of combating corrosion; safety in electrical equipment and control of motors.

Part 2, to be presented in April, consists of articles on the following: description of a new refinery in England; a discussion of utility of nickel-cast irons; an article dealing with design and application of vacuum refrigeration; the second parts of series dealing with corrosion, percolation filtration and inspection of refinery equipment; and a discussion of sodium plumbite solutions as a research problem.

Presented in the symposium are Parts 1 and 2 of the valuable series of articles on inspection of refinery equipment. The author has divided the subject into six headings, as follows, Scope of Inspection, Organization of Forces, Methods of Conducting Inspections, Records Required and Their Utility, Limits for Discarding Equipment and the Results of Systematic Inspection. No where in the literature of petroleum has such a comprehensive and thorough treatment of modern, efficient methods of handling, using, maintaining, revising and final discarding of equipment and processing facilities ever been offered. This manual on inspection of refining facilities will prove of real value for many years.

In the compilation of this symposium each author has been selected because of his proven abilities, experience and reputation in the specific facet of the industry. Each author has been given free rein in the complete covering of his subject and no attempt has been made to edit any author's personal opinion or to stultify him in the free expression of his views. The publishers of THE REFINER do not necessarily endorse any views so expressed; neither do they accept any responsibility or liability for such views or expression of opinion.

Progress in Metallurgy

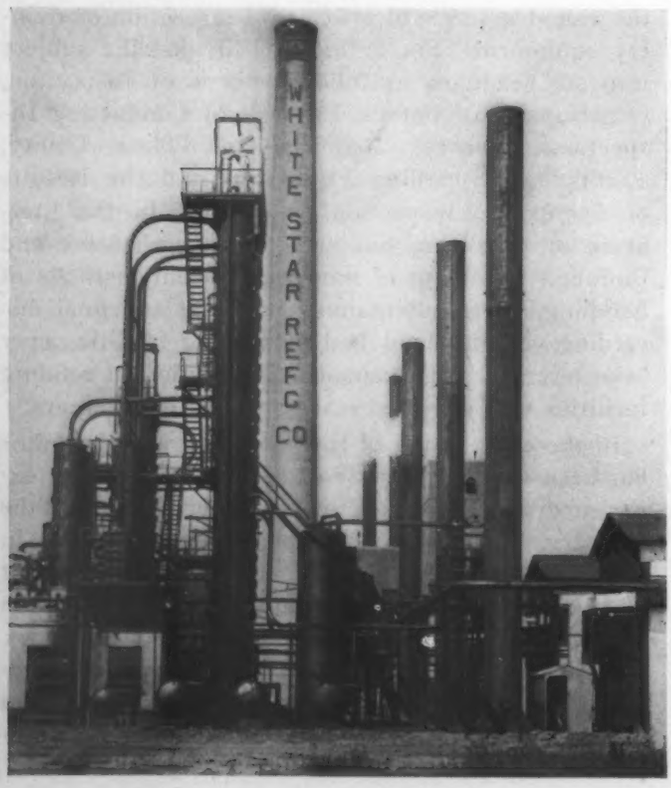
As Applied to Petroleum Refining

PETROLEUM refining covers such a diversified field that the metallurgist has a wide range of problems, wider than in the past on account of new processes, methods of treating, types of equipment and specialty products, as well as greater extremes of temperature and pressure.

The following are a few of the conditions encountered by the metallurgist in the oil refinery:

1. Oils in various stages of refining, as liquid, vapor or solid. Metal temperatures vary from 300° F. below zero to more than 1200°F. Pressures range from high vacuum to 3500 pounds per square inch. As an example of present operating conditions some cracking coils have pressures as high as 1000 pounds per square inch and oil outlet temperatures of 950°F. with metal temperature of approximately 1200°F.

2. Sulphuric acid as used in treating operations and varying from weak to fuming. Other corrosive agents containing sulphur are present in the form of mercaptans, sulphides, etc., in sour crudes and distillates.



3. Chlorine, as a gas or hydrochloric acid, one of the most serious corrosive agents to combat.

4. Water as fresh, sea or high in corrosive constituents, met with as coolants and in various refining operations. In condenser coils and other equipment, corrosion must be prevented by a suitable metal or by chemical treatment.

5. Specialty products, petroleum cosmetics, drugs, etc., requiring purity and freedom from contamination. Special alloys are frequently required for this purpose.

For all of these and other conditions, the designer and others must be cautious in regard to the metals used for the different types of equipment. In many cases experience has taught that in purchasing special metals, they get what they pay for. They must use many different yard sticks to measure their requirements. Not only must they consider resistance to corrosion and strength under various conditions, but other properties such as impact, hardness, coefficient of expansion, resistance to wear, etc., must be carefully considered.

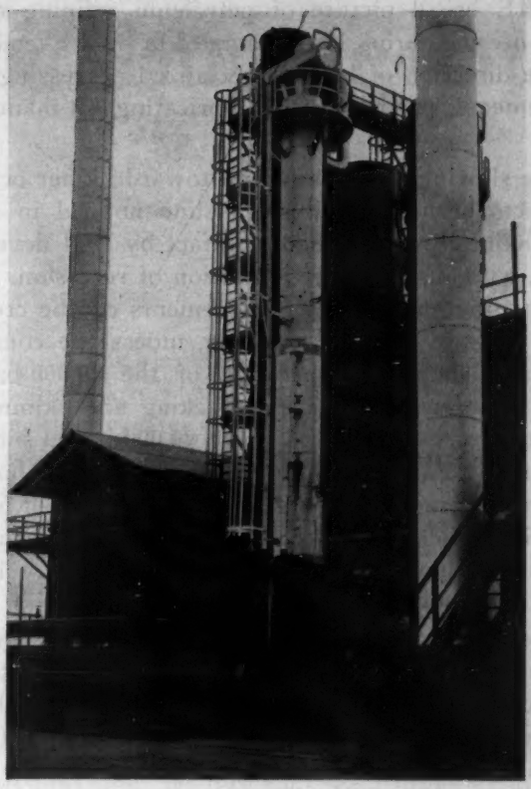
The requirements to be considered depend, of course, upon the conditions. For ordinary atmospheric temperature and pressure, corrosion resistance is the main feature. However, for temperatures up to 800°F. combined with pressure, both strength of materials and internal corrosion must be considered. For more severe conditions above 800°F., the requirements increase; the metal or alloy must be suitable in regard to the following:

1. Strength at elevated temperatures, limiting creep stress, which causes one percent elongation in 1000 hours, 10,000 hours or 100,000 hours, at a given temperature.
2. Resistance to internal corrosion.
3. Resistance to temperature scaling or oxidation.
4. Stability in changing from a ductile to a brittle condition.
5. Thermal conductivity.
6. Coefficient of expansion.
7. Fabrication, machineability, welding properties, etc.
8. Economy.

Special conditions arise in dealing with zero and sub-zero temperatures for which impact is a good

R. L. DUFF

Metallurgical Technologist, General Engineering Department, Standard Oil Development Company



indicator for the selection of a suitable material. Within the last few years, there has been much agitation among the users of low temperature equipment for a cheap metal having a higher impact value than common steel. A large amount of data has been obtained by means of impact tests showing the superior qualities of a nickel steel of low carbon content and two to three percent nickel, at low temperatures. Much of this material has been and is being used for low temperature services.

For many of the special conditions in oil refineries, the use of alloys has been experimented with to a large extent. During the last few years, very few new alloys of consequence have been discovered or approved on the market, particularly for high temperature services. There is no "cure-all alloy" which would meet all refinery requirements. Some alloy manufacturers and fabricators have used the last few years to eliminate difficulties previously experienced in their work. However, there are still many weaknesses to be overcome. Due to good salesmanship and to ignorance of the user, many alloys are considerably over-rated. Most attention has been given to the ferrous alloys although there has been some interest in hard brasses, bronzes and copper alloys for non-sparking tools.

One of the best and most used alloys is the 18 percent chromium and eight percent nickel. However, it is not foolproof and must be used with discretion. In selecting it for any particular purpose, the carbon content and the combined percentage of chromium and nickel are the vital points to consider. It should never be used with an acid fuel or where more than one acid is present. No matter how dilute such acid with salts or solutions of lead, copper, zinc, etc., will cause trouble or failure of this alloy by intercrystalline attack. Recently some alloy manufacturers have added small percentage of other metalloids to the 18/8 alloy with the aim of overcoming some of its shortcomings. This has not been observed by the consumer but has been guaranteed by the producer. The same comments in regard to the addition of metalloids can be applied to the 4/6 percent chromium alloy.

Alloys containing high percentages of alloying ingredients have been used principally for castings for high temperature service. Some foundry men have learned that too much carbon or silicon will cause trouble and have also realized the importance of the elimination of aluminum. Suitable melting and casting temperatures as well as proper heat treatment are essential to give long life.

A few so-called low grade or cheap alloys have been placed on the market mainly as substitutes for common carbon steel and with properties of greater strength and resistance to atmospheric corrosion. A few of these are recommended by their producers for elevated temperature service, but it is well to remember that after passing 1000°F. they lose their strength rapidly and temperature scale, or oxidize very quickly.

A type of substitute for the expensive alloys is the metal-clad material which is being used to some extent. This consists of a common steel with a veneer of lead, nickel, copper, monel of the 18/8 alloy of varying thicknesses. This has interesting properties but its high cost has prevented more extensive use.

In dealing with the problems arising from the many diversified conditions in the oil refinery and in the selection of the most suitable material, the metallurgist aims more and more for safety, true economy, greater standardization and elimination of waste and the best use of all the latest metallurgical developments in connection with alloys, welding, heat treatment, metal clad material, corrosion requirements, and the like.

Developments in

WALTER MILLER
*Vice President Continental Oil Company**

THE broad picture of petroleum refining engineering during 1934 continued to show a tendency in the direction of highly specialized processing improvements, particularly in lubricating oil manufacture.

The slowing up of the trend toward higher octane products in non-premium gasoline noticed in 1933 was definitely established as a fact by 1934 development, with just a slight indication of recession. No outstanding engineering achievements can be credited to 1934 in refinery cracking, unless the completion and successful operation of the 30,000-barrel crude capacity combination cracking and skimming unit at Texas City, Texas, and a 20,000-barrel similar unit in the East can be listed as such. Development and improvement was largely a continuation of previous lines of endeavor. Such trend as there is shows a continuation in the direction of very large integrated skimming and cracking units.

A lessening of the cost of ethyl lead, coupled with the reaching of the octane number "ceiling" kept the subject of "reforming" low octane gasoline into high octane products pretty well in the background. Considerable interest, however, was shown during the year in cracking and polymerizing of refinery gases into high octane motor fuel. The commercial development and application of this activity was greater in 1934 than during any previous year. Fair yields of gasoline of satisfactory stability and high antiknock value were reported, ranging from two to eight gallons per thousand cubic feet of fixed refinery gas, yields varying both with the nature of refinery gas treated and processing methods. Assuming economic feasibility, regarding which there still is difference of opinion, gas polymerization offers the industry a possible outlet for its gases more in keeping with its basic chemical composition and value.

The increased interest of railroads and heavy duty truck and tractor manufacturers served to focus more attention on Diesel fuels. The publicity given the Union Pacific Diesel train, the Burlington "Zephyr" and others operated on special Diesel fuels served to revive the intimations and fears of several years ago as to the ultimate replacement of the gasoline motor by Diesel engines in even the passenger car field. However, an analysis presented at the American Petroleum Institute's annual meeting by a competent authority indicated economic and design limitations might well bar broad commercial application to smaller than five-ton units. The problem of preparing acceptable Diesel fuels came in for considerable study and discussion, although specifications of the ideal fuel have not as yet been drawn. The growing importance of this outlet for the refiners' products is evidenced by an increase of over 200 percent in total horsepower of Diesel motors manufactured in 1934 over 1933, with predictions of over 1,000,000 horsepower to be made in 1935, as compared with 750,000 for 1934 and 250,000 in 1933.

A noteworthy feat in economic engineering and a new experience for the refining industry, was the general control of gasoline production throughout the country during the year, under Petroleum Code Authority, through the Planning & Coordination Committee and the Petroleum Administrator. Procedure was the allocation to and through district agencies to individual plants of a predetermined national requirement. Production of gasoline was so controlled as to reduce stocks at the end of the high consuming season to a point many millions of barrels below those which would otherwise have prevailed.

While observance of manufacturing allocation limitations was effective in the main, unfortunately there was sufficient disregard as to both crude oil and gasoline production (largely in the East Texas field area) to offset the beneficial effect and prevent the improvement in prices which removal of the economic pressure of excessive stocks was expected to bring about. In consequence of which refiners "playing the game" operated for most of the year at a loss. However, during the last quarter new state legislation and more vigorous action on the part of both federal and state authorities looking toward controlling and curbing illicit gasoline and crude production in the East Texas area, give promise that during 1935 this bearish and disturbing factor will be largely eliminated, and refiners able to have a price for their gasoline permitting them to operate at a fair profit. If this does occur there will undoubtedly be ushered in during 1935 an era of engineering activity in the form of new developments and modernizing of old equipment on a scale lacking for several years past.

Expanded use of various solvents in the extraction and refining of lubricating oil is notable. General interest has been broadened to take in as well the commercial aspect of dewaxing and deasphaltizing. Plants having a combined daily capacity of approximately 30,000 barrels of finished oils were completed during the year, and others are under construction or contemplated. The broad operating experience is

*Vice-Chairman for Refinery Engineering, Petroleum Division, American Institute of Mining and Metallurgical Engineers. Presented before the annual meeting, New York, February, 1935.

Petroleum Refining Engineering . . . In 1934

bringing to light, as was to be expected, many improvements in design and operation of solvent plants, tending both to simplify later installations and increase operating efficiencies.

Many refiners are still undecided as to their course. It remains to be seen what the effect will be on the demand of advertising campaigns by those now using solvent processes commercially; how strongly demand will respond to arguments of high viscosity index, negligible carbon residue, et cetera, in view of the fact that the public generally has had little to complain of in lubricating oils already available. A competitive situation similar to the octane race may be in the making.

Another noteworthy development is the increasing trend in automobile motor manufacturing toward design of motors requiring lower viscosity lubricants. The public is being quickly educated along this line by specifications and recommendations of the motor manufacturers, and the popular prejudice against "thin looking" oil which in the past has stopped many an attempt to market lower viscosity lubricants is disappearing rapidly. An economic effect of this tendency will be to increase the requirements for the neutral oil fractions and decrease to some extent the demand for the highly viscous bright stock components. This effect will have to be taken into consideration in future lubricating oil manufacturing plants and design. The increasing horsepower, speed and bearing pressure of automotive equipment are making greater demands upon lubricating oils, and are largely responsible for the above mentioned trend to lower viscosity. The same factors were also influential in promoting the greater general interest in the subject of lubricating compounding agents for the improvement of the oiliness characteristic, bearing load capacity and general stability of the petroleum lubricants used. While the subject itself is now new, the field having been rather exclusively occupied for many years, the widespread interest is evidenced by patent literature, general discussions and the fact that such organizations as the American Society for Testing Materials and the Society of Automotive Engineers are studying extreme pressure and oiliness agents.

Reports of various refining committee activities presented at the A.P.I. annual meeting indicated good, and in some cases more than normal progress being made along the lines of standardization of refinery equipment, fire prevention, accident prevention, control of refinery waste, prevention and control of corrosion, et cetera. A great deal of quiet, persistent and intelligent work is being accomplished by these committees, work which seldom reaches the headline stage but is made available to the industry by suitable reports and bulletins.

Scene at Socony-Vacuum refining plant at Paulsboro, N. J. This is view of first Clearosol Process commercial unit operating in U. S. High propane towers in foreground. On right extraction shed, and behind it is the solvent recovery system. This huge, costly unit marks the first revolutionary step in refining crude oil. Courtesy: Socony-Vacuum Oil Company, Inc.

Inspection of
Oil Refinery Equipment

PART 1

FRANKLIN L. NEWCOMB

Supervising Engineer, Safety Inspection Division, General Engineering Department, Standard Oil Development Company

I—SCOPE OF INSPECTION

IN determining the scope of an inspection, it is necessary to determine what equipment requires inspection and the frequency of such inspection.

EQUIPMENT REQUIRING INSPECTION

A modern, complete refinery contains vacuum stills, shell stills, pipe stills, cracking units, gas compression and absorption plants, gas holders, treating plants, filtering plants, dewaxing equipment, boiler houses, air compressors and receivers, refrigerating equipment, acid storage and handling equipment, acid restoring plants, shops for all mechanical trades, pumps, steam engines, electrical equipment, many measuring, recording and control instruments, a maze of pipe lines and many other things, including a large number of various sized tanks for the storage of crude and the various petroleum products. There is also usually a rather elaborate system of fire-fighting facilities.

Certain of the equipment mentioned in the preceding paragraph may come under the jurisdiction of some state or local ordinance requiring inspection by persons employed or licensed by such authority. Such equipment would include boilers, and in some states, air receivers and the like. It is felt that where the law requires inspection of equipment by designated authorities, such equipment should not be inspected by the oil company's personnel but the responsibility for the inspection and condition of such equipment should rest entirely in the authority designated by law. Therefore, any equipment coming under this category should be eliminated from consideration in determining the equipment to be inspected by the oil company's inspection department.

The inspection and maintenance of electrical equipment requires a highly specialized knowledge and it is felt that any inspection of such equipment can best be done by the electrical department and that the responsibility for inspection of such equipment should rest with them.

The inspection and maintenance of machinery is largely one of taking up undue wear and play in moving parts and in properly aligning such machinery so that it functions smoothly and quietly. In general, therefore, it is felt that the machinists are better qualified to care for such equipment than any specially organized inspection department. Therefore, in considering the inspection of machinery such inspection should be confined to special cases where specifically requested by the machinists.

This leaves for the inspection department all types of vessels containing oil vapors, gases, air, acid and various chemicals, whether they operate under a vacuum, no pressure other than the head of liquid, or elevated pressures. It also brings under the jurisdiction of this department, pipes, valves, fittings, structural work and any other equipment not specifically assigned to other departments.

FREQUENCY OF INSPECTION

Many factors affect the frequency at which inspections are necessary. The principal factors are:

The character of the contents.

The pressure.

The temperature.

The material used in construction.

The amount of material above that required for strength available for corrosion.

Protection against corrosion.

Vessels and pipe lines may contain oil, acid, strong alkalies, gas, air, and various chemicals used in the refining process. Some oils contain only small amounts of sulphur and little, if any, corrosion is experienced. Other oils are high in sulphur, and other corrosive compounds, and cause rapid and severe corrosion. The most common and extensively used acid in the petroleum industry is sulphuric. The corrosiveness of such acid is inversely proportional to its strength, the weaker acids causing more rapid corrosion than the stronger acids. The alkalies used generally do not attack the material of construction. The gas handled in a refinery is largely the product of the oil handled and its corrosive characteristics closely follow that of the oil. Air is handled mainly under pressure for mechanical work and, since under pressure it will hold less moisture, the insides of such equipment are usually wet and subject to corrosion similar to atmospheric corrosion experi-

THIS is the first of a series of five articles on the important subject of inspection of refinery equipment. Mr. Newcomb has divided the subject into six divisions as follows: Scope of Inspection, Organization of Inspection Forces; Methods of Conducting Inspections; Records Required and Their Utility; Limits for Discarding Equipment and Results of Systematic Inspection.

Nowhere in the literature of petroleum refining has such a comprehensive and thorough treatment of modern, efficient methods of handling, using, maintaining, revising and the final discarding of equipment and processing facilities ever been published.

The REFINER is glad of the opportunity to present such useful information and data to its readers and is grateful to the author and to the executives of Standard Oil Company of New Jersey for the willingness to serve the industry in passing such valuable experience records along to others.

enced on exposed structural work. In addition, the air supply to the compressors may be polluted with acid fumes or other corrosive gases which will cause accelerated corrosion over that usually experienced in compressed air systems. Some of the latest developments in oil refining require the use of various chemical solvents such as cresol, sulphur dioxide, croton aldehyde, aniline, furfurol, acetone, phenol, dichlorethylene, trichlorethylene, carbon tetrachloride and others. The experience with some of these has been so limited under the conditions of use that little is known concerning the corrosion which may occur.

The pressures and temperatures prevailing frequently have a decided effect upon the corrosive possibilities of the substances mentioned above. In general the higher the pressure and/or temperature, the more corrosive the substance.

The material of construction will have an important bearing on the corrosion experienced. Some materials may be easily attacked by the corrosive substances present. Other materials may present considerable resistance but still show a definite corrosion rate. Still other materials may be entirely resistant to the corrosive substances present.

In the case of material subject to corrosion, the amount of material over and above that required for strength must be taken into consideration.

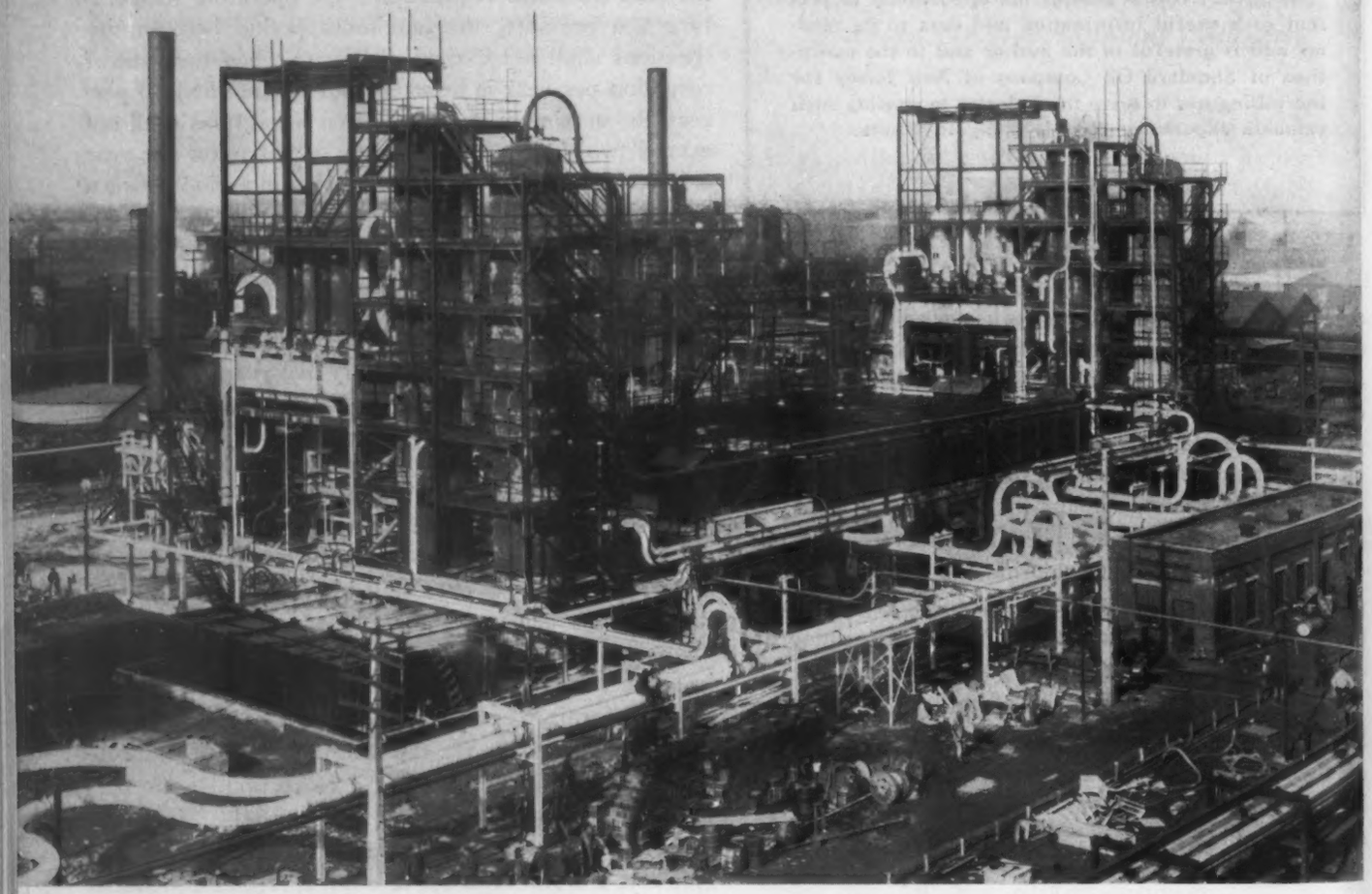
In many cases the material may be protected against corrosion. Material exposed to the atmosphere is frequently painted or coated with some protective substance to prevent atmospheric moisture and fumes in the atmosphere from reaching the material of construction. The interior of equipment is frequently protected with various coatings such as sprayed-on metal, sheets of corrosion resistant material, concrete, acid-resisting brick and similar things. Some methods of protection are more permanent in character than others.

In order to determine the frequency with which inspection should be made, one must consider all of the factors which may affect the strength of the structure. The API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases provides that the maximum period between inspections shall not exceed one half of the estimated remaining safe operating life of the vessel. This code further provides that when the rate of corrosion per year is 10 percent or more of the wall thickness required for the operating temperature and pressure, the maximum period between inspections shall not exceed one year; when the rate of corrosion per year is between four percent and 10 percent, the maximum period between inspections shall not exceed two years; when the rate of corrosion per year is lower than four percent the maximum period between inspections shall not exceed five years; when the contents are corrosion inhibiting and practically no external corrosion is expected the vessel need not be inspected as long as it remains in the same service, but the metal surface of the vessel shall be examined on either the outside or the inside at least every five years. This code provides that all vessels above ground be given a visual inspection at least once a year to determine the condition of supports, linings, if any, insulation and the general condition of the vessels. There might be added to the above that, in this annual inspection, the condition of all attached piping, thermocouple wells and other equipment should also be determined since these things, being of lighter construction and having a lesser corrosion allowance, may be in an unsafe condition and may also be subject to strains which will cause incipient cracking or other forms of weakness. Section I of this code also contains instructions for the determination of the probable corrosion rate and for the correction of the corrosion rate during the life of the vessel. Since this code represents the joint experience of the petroleum industry, it is considered safe and it is recommended that pressure vessels containing petroleum liquids and gases should be inspected at least as frequently as required by the inspection section of this code. Other pressure vessels do not differ materially from petroleum pressure vessels, except in that generally they operate under lower temperatures. It would, therefore, seem logical to determine the maximum intervals between inspections for such vessels by the same API-ASME code rules as are used for determining the inspection intervals for petroleum vessels.

Since a great deal of the equipment in a refinery requiring inspection may not come under the category of pressure vessels it is necessary also to determine intervals between inspections for such equipment. To do this one must take into consideration all the factors af-

fecting the safety of the construction and determine the probable rate at which it is approaching a dangerous condition and from this determine the necessary intervals between inspections somewhat along the lines outlined for pressure vessels.

The above provides a means for determining the frequency with which an individual pressure vessel, or individual piece of equipment should be inspected. However, it should be borne in mind that usually an operating unit in a refinery consists of a combination of a number of pressure vessels, pumps, furnaces, and a great deal of piping. While one of the pressure vessels in such a unit might only require inspection once in five years, another might require inspection once every year and the piping might deteriorate at such a rate that, unless inspected at much more frequent intervals, it would become unsafe and might even fail. Since certain parts of the equipment require much more frequent inspection than others, it is frequently the practice to inspect certain parts of the equipment at the completion of every run to determine that no unusual conditions have occurred and also, to make a complete inspection of the entire unit at fixed periodic intervals even though the rules for determining the frequency of inspection of some of the parts might permit a longer interval to elapse between inspections. For instance, high pressure cracking equipment might have parts of the piping, the furnace tubes, and similar equipment inspected at the completion of every run and the units be given a thorough general inspection as frequently as twice a year, while in the case of a pipe still the unit might be given only a very casual inspection without taking measurements of any kind at the completion of the runs and be given a thorough general inspection once a year. In both cases parts of the equipment during the general inspection might be permitted to operate several times as long if the rules given in the API-ASME code were followed. However, those following a procedure as outlined above feel that the cost of such inspection is well justified since it tends to maintain the units continuously in first-class condition, and also gives ample warning as to when replacement of various parts may be expected so that material can be obtained and on hand ready to install when a given part reaches its safe limit.

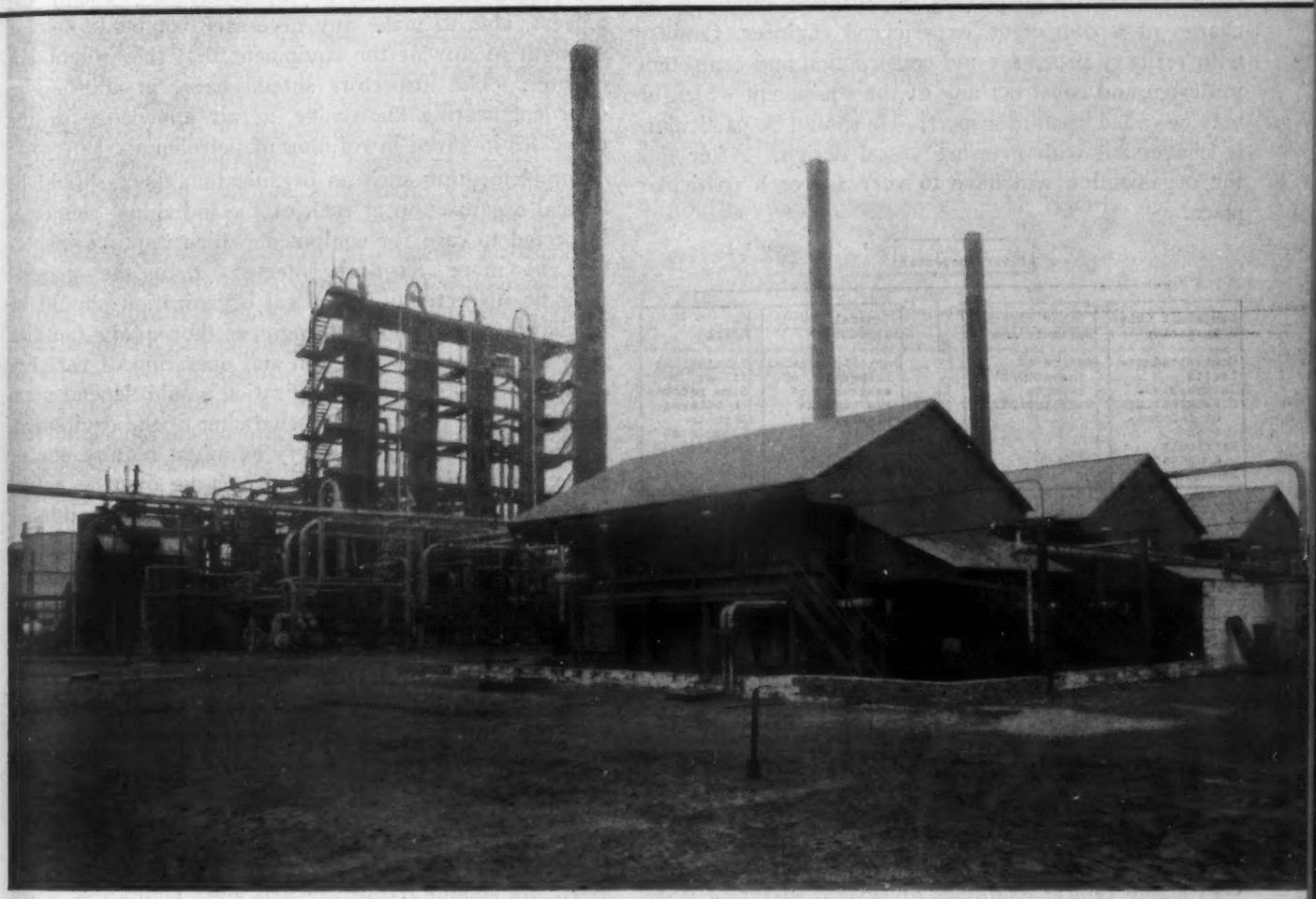


Typical Cracking Unit (new unit under construction adjoining)

PARTS OF EQUIPMENT REQUIRING INSPECTION

It should be constantly borne in mind that no positive

statement can be made as to where corrosion or other deterioration will not be found. On the other hand, experience has provided many guiding principles by which it can be stated with a fair degree of certainty where trouble is most likely to be experienced. There is a great difference between these two statements and the attitude of the inspector should be that he may find corrosion anywhere until he has assured himself that there is none. Whenever any change is made in the operation of a piece of equipment whether it is a change in pressure, temperature, character of the contents, substitution of a corrosion resistant material for one which formerly was badly attacked, or any other change, the inspector should again take the attitude that corrosion may be found at any point where previously it had not been experienced.



Debutanization and Stabilization Unit

MOST SERIOUS CORROSION

Some of the points where most serious corrosion is to be expected are as follows:

In vessels containing corrosive liquids frequently the most serious corrosion is experienced at the liquid level. However, sufficient investigation of the remainder of the vessel should be made to determine that this is the case.

In vessels through which vapor or gases flow the most serious corrosion is frequently experienced in the vicinity of the inlet.

In piping through which liquids are flowing, it is generally safe to assume that the higher the velocity the greater will be the corrosion. Also at points where turbulence occurs, the corrosion will probably exceed that found at other points and parts usually badly affected are those immediately adjoining points at which there is a change in direction of flow. In the case of pipe bends, usually the outside of the bend will be affected more seriously than the inside, but just beyond the end of the bend the most serious corrosion is frequently found opposite to the point where it is found in the bend of the pipe.

GATE VALVES

Gate valves frequently are found to be seriously affected in the body between the seats apparently due to the turbulence caused by the passage through the parallel seat rings. This is particularly true in valves which are used for throttling purposes.

It is impossible within the scope of an article covering as broad a field as this one to do much more than

point to the fact brought out earlier, that it never can be positively stated where corrosion will not be found. The more inquisitive the inspector, the better will be the results of his inspection.

II—ORGANIZATION OF INSPECTION FORCE

The organization required to competently inspect the equipment in a refinery or group of refineries is dependent upon the nature of the equipment, the amount of equipment, and whether or not the organization is local, that is, confined to one plant, or whether it is intended to coordinate the work at several plants. Under any circumstances the inspection organization should be in charge of a competent, experienced engineer, familiar with refinery processes and construction and competent to design and construct any of the equipment which he may be called upon to inspect. He should be particularly conversant with pressure vessel design. After this the organization will have to vary for each particular place.

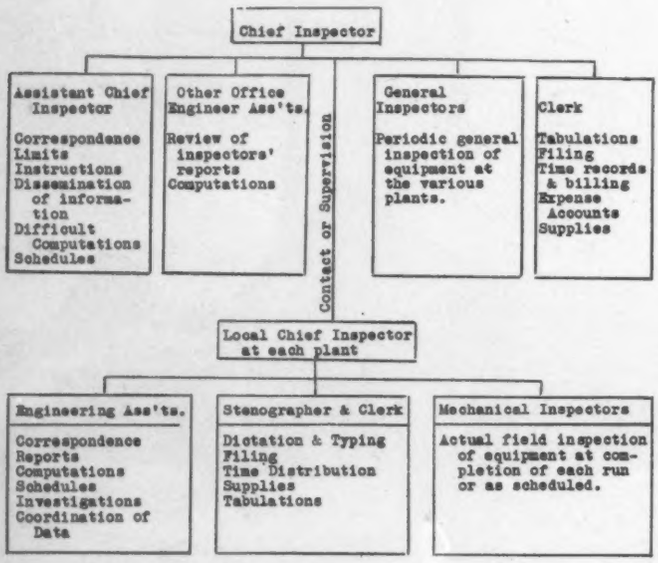


FIGURE 1

Typical inspection service organization suitable for a large company with widely scattered properties.

Probably typical examples of several different types of organization will best illustrate ways of organizing successful inspection groups. As a first example, an outline of an organization suitable for a large oil company, with refineries widely scattered, will be given. (See Figure 1 for a typical organization chart.) Such an organization would require a central organization which would make general periodic check inspections of the equipment at stated intervals. Such a central group would require a semi-executive head who would coordinate the entire work and would have under him at his headquarters several well experienced assistants and in addition a record clerk and sufficient stenographic service to turn out all work promptly. Working under the supervision of this office force, there would be a corps of traveling inspectors who would be sent from point to point to make a general and rather complete inspection of all the equipment at fixed periodic intervals. These inspectors should have sufficient training so that their judgment could be trusted in cases where fixed rules cannot be laid down. They should be able to survey equipment which they have not previously seen, study out its processes and analyze the entire problem from a safety standpoint, and should be able to organize the inspection of the equipment and to advise the local people at the completion of each inspection covering points which they should watch. All of this group aside from the record clerk should be preferably be graduate engineers, able to make any necessary computations for strength of any of the equipment that they might encounter. The inspectors should have, in addition to their engineering knowledge, a fair knowledge of the processes involved in refining of petroleum.

Supplementing such an organization there should be a local organization at each of the individual refineries inspected to care for equipment which requires inspection at more frequent intervals than the general periodic inspection. The local organization should be in charge of a competent engineer thoroughly familiar with the design, construction and operation of refinery equipment. His office organization would depend upon the size of the plant and the character of the equipment. In the case of a large refinery he might require one or more engineering assistants. To carry out the actual inspection work such as measuring thicknesses and looking for signs of corrosion, he would require a number of competent mechanical inspectors. It would probably be advisable to pick such inspectors from both the boilermaker and pipe fitting trades. Men picked for such inspection work should be above the average mechanic in intelligence, should have initiative, be willing to take a certain amount of responsibility and should be able to describe in writing that which they have seen in the field so that they can submit understandable reports and can tabulate the necessary data. The person in charge of such an inspection or one of his engineering assistants should frequently look over equipment when it is down for inspection and should confer frequently with the mechanical inspectors. In addition, checks should be made of the measurements taken by the inspectors to assure that the utmost care is being taken in gathering the necessary data. The engineering inspector in charge of such local inspection should keep a complete list of each piece of equipment inspected, schedule approximate dates for inspection, make arrangements to secure the equipment, assign the work to the inspectors, supervise the inspection, study the methods employed, receive the reports and data from the inspectors, forward the necessary reports to interested parties and request the mechanical department to make the necessary repairs. In addition, the data received should be coordinated and tabulated so that a

continuous running record of the equipment will be kept, corrosion rates can be obtained and conclusions can be reached as to the suitability of the material for the service. Also such an organization should closely cooperate and work with the general inspectors when they visit the plant. The local organization might either be under the jurisdiction of the general organization or might come under the jurisdiction of the refinery.

With such an organization as outlined above, the chief inspector should be a person with considerable authority. He should have the right to order replacement of unsafe equipment and such order should be obligatory unless reversed by higher authority after review of the arguments on both sides. He should issue instructions covering methods of making inspections and establish safe limits for the various equipment. He should establish a means of informing all interested parties concorning corrosion, failures, new methods of inspection and in general should act as a clearing house for accumulating and disseminating all essential information for the safe design and maintenance of equipment. His office organization should receive comprehensive reports from the general inspectors, review same and prepare reports to the management advising the status of the equipment at the time of inspection. The chief inspector should also confer frequently with the local inspection groups, whether or not under his jurisdiction, and talk over with them problems of mutual interest and should give them the benefit of the broader experience he has acquired through contact with a number of plants.

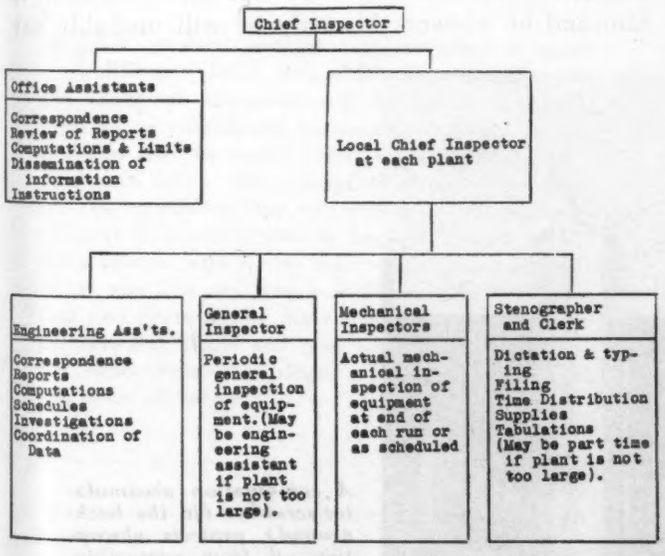


FIGURE 2

Typical inspection service organization suitable for an oil company with closely grouped properties.

As a second example, an outline of an organization having several refineries rather closely grouped will be given. (See Figure 2 for a typical organization chart). In such case, there should be a competent engineering inspector in charge of the entire group with his headquarters centrally located, preferably in contact with the management of the company. He would supervise a local organization at each of the plants. Such a local organization would take care of the entire inspection service without the benefit of periodic general inspections by an outside group. Each local organization should be in charge of a competent engineering inspector who would in turn have an organization similar to that described for the local organization of the larger group outlined above, except that such a local group should contain a sufficient number of engineering inspectors so that periodically a complete general inspection of the equipment could be made by the engineering inspectors to supplement the inspection made by the mechanical inspectors.

In the above case, the engineering inspectors should submit detailed reports covering the periodical inspections and should include their comments on the condition of the equipment inspected. Such reports should be

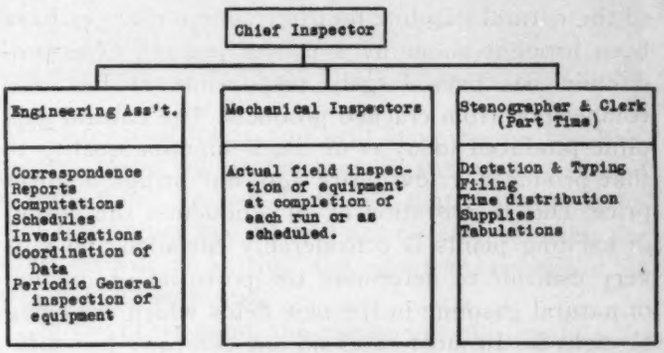


FIGURE 3

Typical inspection service organization suitable for an oil company with a single refinery.

forwarded to the headquarters of the chief inspector and reviewed by him. The chief inspector should submit such comments on these general inspections as he feels necessary to best coordinate the work of all of the plants and to keep the management informed as to the condition of the equipment.

As a third example, an outline of an organization suitable for an individual refinery will be given. (See Figure 3 for a typical organization chart). Such an organization should be in charge of a competent engineer who should be thoroughly familiar with the design, construction and operation of the equipment. Depending upon the size of the plant, he should have one or more engineering inspectors and the requisite number of mechanical inspectors to make both periodic engineering inspections of the entire equipment and to make the necessary run to run inspections between periodic inspections. In this case, the person in charge of the inspection should submit a detail report to the management covering the condition of the equipment as revealed at the periodic engineering inspections.

The Trend in *Design, Construction and Operation of* Gasoline Plants

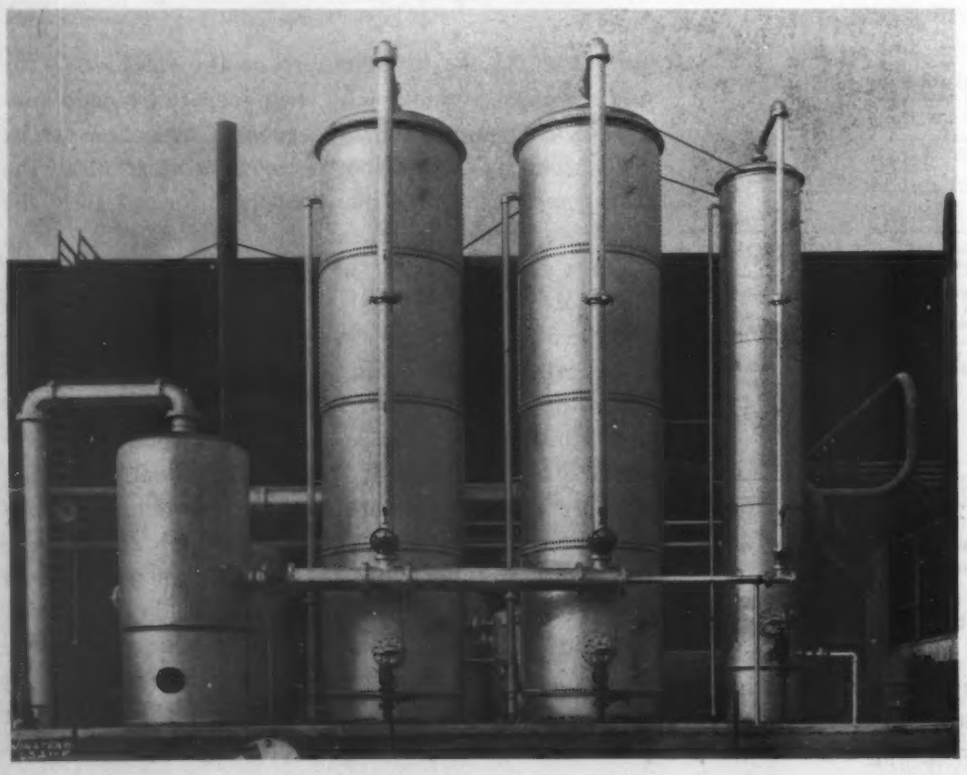
JULIAN A. CAMPBELL
Consulting Engineer, General Manager, Lomita Gasoline Company

A FEW years ago when one was contemplating building a gasoline plant the question asked by those providing the capital was "In how many months will it pay out?" Now the question is, "Do you think it will ever pay out?"

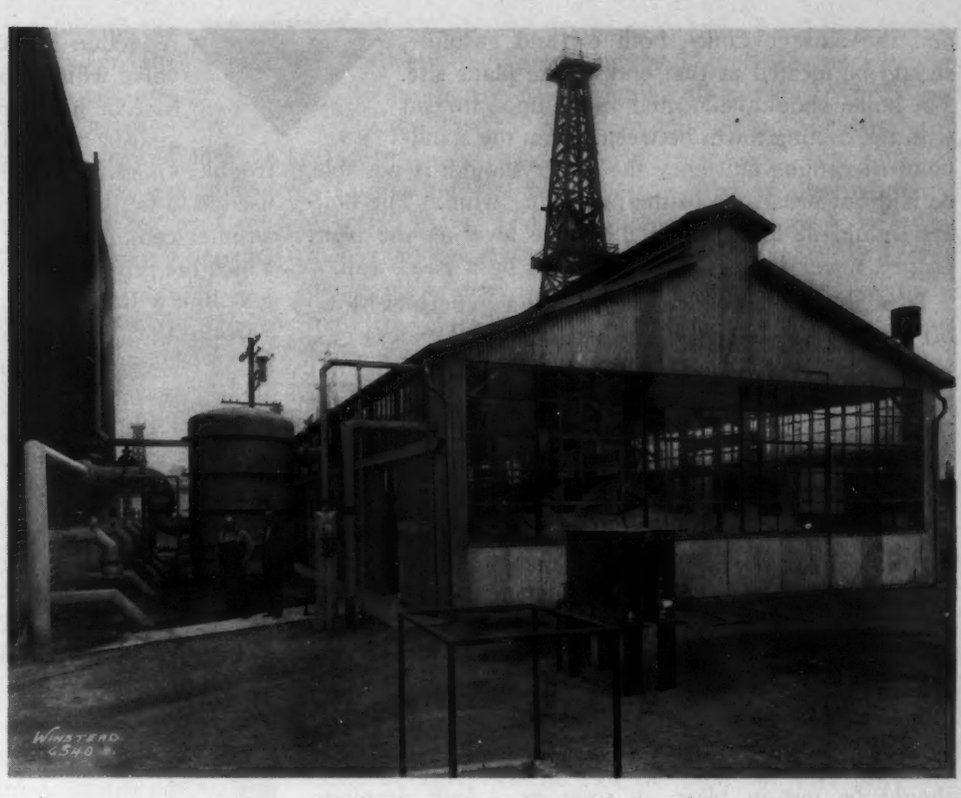
The past few years have brought many changes to the natural gasoline industry. These changes have been brought about by a poorer market. Over-production has been largely responsible as has also competition from cracked products. The natural gasoline produced today is of much superior quality to that produced a few years ago, but brings a lower price. Due to proration of oil production the output of existing plants is considerably curtailed and it is very difficult to determine the potential production of natural gasoline in the new fields which are being brought in. In most cases no one company has sufficient acreage in the new fields to warrant the construction of a large plant and under present conditions it is not profitable to build a small one. Many of the companies, hoping for a change for the better, do not care to lease their gas on a long term contract, and it is difficult to find a reputable operator who will gamble his own money in building a large plant unless he can see his way to eventually pay out on his investment.

This problem is being intelligently met in some of the newer fields by cooperative effort in a way that prevents duplication of plants and pipe lines and permits one company to make a reasonable operating profit and pay the others a reasonable royalty. In this way all of them profit.

When such a deal is worked out and the question of building a plant is considered, the first thing to decide is "How much second-hand equipment shall we use?" Second-hand equipment is the construction engineer's bete noir. If you put the above question to him and he answers honestly he will probably say



A combination accumulator-scrubber (in the background) protects absorption oil from contamination. An outlet scrubber of special design is provided to agglomerate and accumulate mist particles which catches and saves oil that would otherwise go out as mist with the dry gas.



A large vacuum mist extractor is provided for the protection of the compressor plant.

"none at all." But why this strenuous objection on the part of the engineer to the use of used equipment? In the first place he is going to do a lot welding in the plant and he knows it is dangerous to weld on pipes connecting various vessels that have had gasoline or absorption oil in them. He also knows that it is hard to make a nice looking lay-out with equipment moved in from other plants because the outlets have a habit of falling on the opposite side from where you want them and they do not come at the right elevation. He knows that the pumps will all have to be gone over and re-gasketed, the valves will have to be taken apart, ground in, oiled and repacked, pipe will have to be scaled and inspected, the asbestos blocking and pipe covering will have to be handled very carefully and patched out. He knows that the material is likely to arrive on the job in heterogeneous loads and will have to be handled, sorted, inspected, tested and rehandled and moved several times. In fact he knows that his labor costs will run higher and he will not be able to make the time record of putting the plant in operation of which he is so proud.

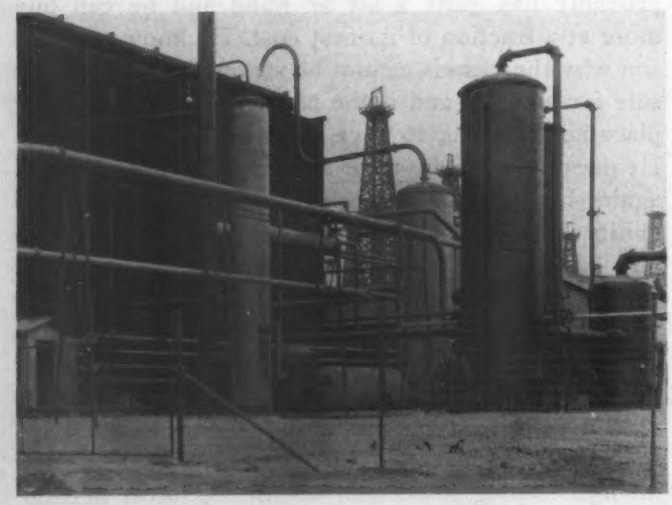
"THE modern natural gasoline plant is quite different from the plant of yesterday, but the plant of tomorrow will be better arranged, even more completely automatic—if such an expression may be used—; less wasteful, more efficient and safer," Mr. Campbell states. "But even so," he concludes, "we will still have the personal element to contend with as long as human beings must operate and watch over operations, and each of us who has any responsibility for the construction and operation of these plants, should adopt as his personal motto and pass on to all those under his supervision this slogan 'Eternal vigilance is the price of safety'."

On the other hand, the owner sees no reason why he should not use considerable used equipment. He probably has quite a bit on hand and he can buy more at a fraction of its first cost. He knows no reason why the vessels cannot be steamed out and made safe for welding and if the nozzles fall in the wrong place he is willing to have them cut out and moved. He does not see why most of the pipe cannot be used again. He has confidence in his engineer's technical ability but realizes that they see things from a different angle, so they get together on the job, talk things over and probably finally decide to use new pipe in the cooling tower, modernize the plates in the absorber, evaporator and stabilizer, use new valves in critical places, change over to a hot dephlegmating system, put in larger lines where before there were certain bottle-necks, erect a new modern cooling tower and install the latest in automatic control equipment. The result is a modernized plant of neat appearance at a cost considerably less than a new plant but one of which both the owner and the construction engineer may well feel proud.

Because of several disastrous explosions and fires in gasoline plants in recent years, more attention is now being given to the location and arrangement. Before a plant layout is drawn up, a careful study of wind conditions should be made. The direction from which the wind blows the least should be determined

and the storage tanks, both oil and gasoline, should be located at that end of the plant site. The boiler should be located on the opposite end with the cooling tower between. From the standpoint of cooling efficiency the tower should, if possible, be laid out broadside to the prevailing wind. The boilers should at least be on the same level as the plant proper, never lower unless protected by a good wall.

It is an excellent idea to provide a generous blow-off stack 40 or 50 feet high into which all excess gas, waste exhaust steam and plant vapors that are not re-cycled are piped. This can be mounted over a pit into which the boiler blow-off pipes lead. Promiscuous vents around the plant should not be tolerated since they are not only a serious hazard in themselves but the air is contaminated by them, making it difficult for the operator to smell gasoline or gas from leaks. The atmosphere around the plant should be kept as pure as possible for this reason. Leaks of any nature, whether gasoline, gas, oil or steam should be stopped as soon as discovered. The plant warehouse should contain an assortment of thread-clamps and pipe-clamps and if these are required they should be put in place as soon as a leak develops. The superintendent should keep a note book and when one of these is put on, its location should be noted and at the first shut-down of the plant or of the unit where these temporary repairs are made, permanent repairs should be effected. Operators should be instructed to report to the superintendent at all times anything which should be changed or repaired at the next shut-down, and these should be noted in the book.



A 20,000-gallon plant on two city lots. Precaution must be taken to prevent fire. Note the vent stack in the center for dissipating vapors.

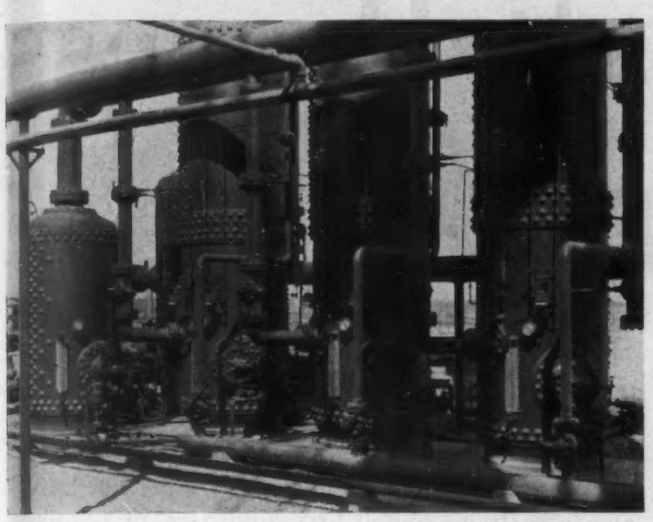
One of the danger points in the modern gasoline plant is the condition of carrying 175 pounds to 200 pounds pressure on the stabilizer and only 10 to 30 pounds on the finished gasoline storage tanks. The reduction is usually made by the float control valve which maintains the level in the stabilizer base or in the re-boiler. There are several safeguards that may be effectively used to prevent trouble. One of the best where several storage tanks are used is to tie them all together at or near their tops with an inter-communicating line, so that should the tank into which the production stream is flowing be overfilled, the gasoline will go over into one of the low-gauge tanks. All storage tanks should, of course, be protected by ample relief valves. In view of the fact that there is a high pressure to be dissipated, between the stabilizer and the storage, it is well to use small lines. The finished gasoline cooler may be designed to take a high pressure drop which increases turbulence, making it much more effective, and a one-inch line with a terminal difference of 100 to 150 pounds will handle a lot of gasoline in 24 hours. Making this drop through plenty of line and cooler resistance will limit the flow so that even though the float valve sticks wide open, the storage reliefs will be able to take care of the pressure increase. Having all the tanks tied together gives multiple relief in case the one on the run tank into which production is flowing should stick. An auxiliary high pressure tank with a reducing regulator between it and the storage and a float operating a high level alarm is an added precaution.

Pipe will eventually corrode out. Underground piping should be covered with a good protective coating. Where climatic conditions will permit, it is well to put the connecting piping above ground. Many of the pipes such as gas, vapor and steam may be supported at an elevation of eight feet or higher. The oil, water and gasoline piping may be put on light concrete piers a few inches above the ground at a cost less than that of trenching or burying them. If this is done, however, care should be exercised in the layout so as not to obstruct passageways for moving in additional equipment in case of expansion and not to provide obstacles to the free movement of fire fighting apparatus. When such an installation is made, the pipes may be preserved by painting or protective coating and any leaks which develop are readily detected and may be repaired with facility.

Where the old style cooling towers are used, care should be taken in the layout so that wind-drift will not blow on apparatus or piping since it is very difficult to find any kind of paint or protective coating that will withstand its action. This is not a problem with the modern improved cooling tower but even so the layout should be made so that the prevailing wind gets an uninterrupted sweep at the tower and it is advisable to keep buildings, tankage and apparatus in the clear.

In the modern gasoline plant, careful attention is given in the design to the elimination, before it has

an opportunity to contact and contaminate the absorption oil, of the crude mist carried by the gas. This is effected by installing adequate and efficient mist-extracting scrubbers, one a vessel properly reinforced to withstand vacuum and located ahead of the compressors, and the second as a combination scrubber and accumulator on the discharge of the gas after-cooling coils ahead of the absorbers. The condensate caught in this second scrubber is very likely to contain some heavy ends which should not be permitted to get into the absorption oil and it is good practice to handle them through a separate dephlegmating or fractionating still.



Battery of 450 pound absorbers showing all piping above ground. Note inlet and outlet scrubbers.

The average gasoline plant has a capacity in its oil circuit of around 8000 to 10,000 gallons, and circulates around 18,000 gallons per hour so the circulating oil passes through the distillation unit 40 to 50 times a day. Even assuming that no crude whatever gets into the system, this repeated heating and agitation of the absorption oil, causes it to darken from breaking down and concentration of gummy fractions, and in order to maintain high absorption and heat transfer efficiency, it should either be replaced by fresh oil or distilled and fractionated for the elimination of such fractions. Most modern gasoline plants contain equipment for this purpose either in the form of steam-heated vacuum columns or atmospheric columns with direct-fired heaters.

The present day trend in cooling tower design is to use siding which permits the free passage of air through the tower but which eliminates wind-drift. This is desirable not only from the angle of saving water but as mentioned before, it will eliminate a bad source of corrosion of equipment and piping.

Builders are looking carefully into operating costs and as gas becomes more valuable, are turning to gas engine drive for pumping of water and oil as more economical than steam generation.

Complete drainage systems are being put in with segregation pits and where oil-conditioning units are in operation, all the pump drippage and trench drainings can be salvaged and reclaimed.

Liquid petroleum gas is now a by-product of many gasoline plants and where there is a market, helps to defray the operating expenses. This product introduces an added fire hazard and should be carefully handled. It is especially dangerous because, being heavier than air, it clings to the ground and does not diffuse nearly so readily as natural gas.

The manufacturers of automatic control equipment have not been idle these past few years but have done some very fine work in perfecting existing methods and developing new ones. The designing engineer can today get practically anything he wishes in this line and he has learned by experience that automatic control equipment is one of the best investments he can make.

Considerable thought is now being given to selective condensation of reflux for the evaporators, as engineers are practically all in agreement that a finished product should not be used for this purpose. More care is also being exercised in de-watering in the fractionating section of the evaporator since close fractionation is impossible in the presence of steam.

The next year or so will probably bring forth some very interesting developments in fractionating plate design. There is always the search for the perfect plate; one that will give the maximum in intimacy of contact, that will positively eliminate channeling, have a wide range of through-put and that is adaptable to the service of absorption, distillation and stabilization. When we look back and consider the decided improvement in extraction and stripping which was obtained when we changed over from the packed filling to the bubble plates, we wonder if there is not still decided room for improvement.

Where boiler battery must be located at lower level than plant they should be well protected by a retaining wall.

The Gard-Aldridge Asphalt Process

R. T. HOWES and
C. N. WHITAKER

THE Gard-Aldridge Process, as developed by the engineering firm of Howes and Whitaker, has proven conclusively that products such as roofing saturant, coating, mineral rubber, water seal, battery seal, etc., can be produced with qualities superior to those of oxidized products made by processes now in use. The additional advantage for the new process is the reduction of running time to from one half to one third of the time now required. It has also been determined that the steam and air requirements are considerably less. The commercial runs have also shown that still cleaning and maintenance costs are practically eliminated. These advantages mean reduced manufacturing costs.

The features responsible for the success of the new process are the manner in which the air is introduced, and the perfect control which can be maintained during the reaction period. The reduction in the required amount of air is obviously due to more complete utilization of oxygen. The average consumption of air per barrel charged, using the conventional process, is 6000 cubic feet, while the average for the Gard-Aldridge process is less than 1500 cubic feet.

By referring to Figure 1, it will be evident that any existing blowing plant may be readily converted to the new process, it being only necessary to rebuild the still interior, install the specially designed circulating agitator, and supply the required cooling facilities. In case of new installations, advantage may be taken of the higher efficiency to be obtained by pipe still operation. Designs for this type of plant are available.

Although the first installation of the Gard-Aldridge process was made as early as 1926, a more recent conversion was made in a 10x20 still. Operation was on a commercial basis with charges of 200 to 250 barrels. The results of these runs proved that the blowing time is considerably reduced and that operation is easily held under positive control. After a series of runs were made, it was noticeable that there was no tendency to form carbon stalactites in the still.

The conventional method for the manufacture of oxidized asphalt requires a shell still, mounted on the usual brick firebox, which is equipped with auxiliary air ducts for the purpose of removing the excess heat generated during the time oxidationis occurring. Various means are provided for the introduction of process air, or near, the bottom of the still. The object is to obtain the greatest uniform turbulence with resulting greater contact between charging stock and air. A perforated pipe for bottom steam, and jets for top steam are provided. Vapors pass from the still to a condenser, or to atmosphere.

The still is charged, at any convenient temperature for pumping, with an asphaltic residuum or flux having a gravity of 11.5 to 14.5 A. P. I. Air is usually introduced at or near the start of the run while the charging stock temperature is being raised. When the charge temperature is approximately 350°F., fires are "cut" and process air input is increased to a maximum of as much as 1000 cubic feet per minute for a 150-barrel charge. At this stage of operation, it is customary to introduce top steam to eliminate the possibility of a flash.

As the oxidization progresses, the temperature of the charge rises until it is necessary to open the vent doors in the setting to admit cold air along the sides and bottom of the still. The final temperature varies in different plants between 450° and 550°F. To make a product with a 220°F. melting point may require 24 to 48 hours, depending upon the characteristics of the charge, amount of air introduced and the average temperature. "Bottom" steam is used for the purpose of obtaining the proper flash, and the desired penetration-melting point ratio.

The Gard-Aldridge process is essentially intimate mixing of air and stock at a suitable temperature. This intimate mixture is obtained by the circulation of large volumes of hot stock into which an economical amount of air is introduced. This is accomplished by a vertical low head pump, which we designate as a circulating agitator. The structure of this unit is such that a predetermined quantity of stock is metered to the pump impeller which forces the flow through a throat wherein the air is introduced. Ro-

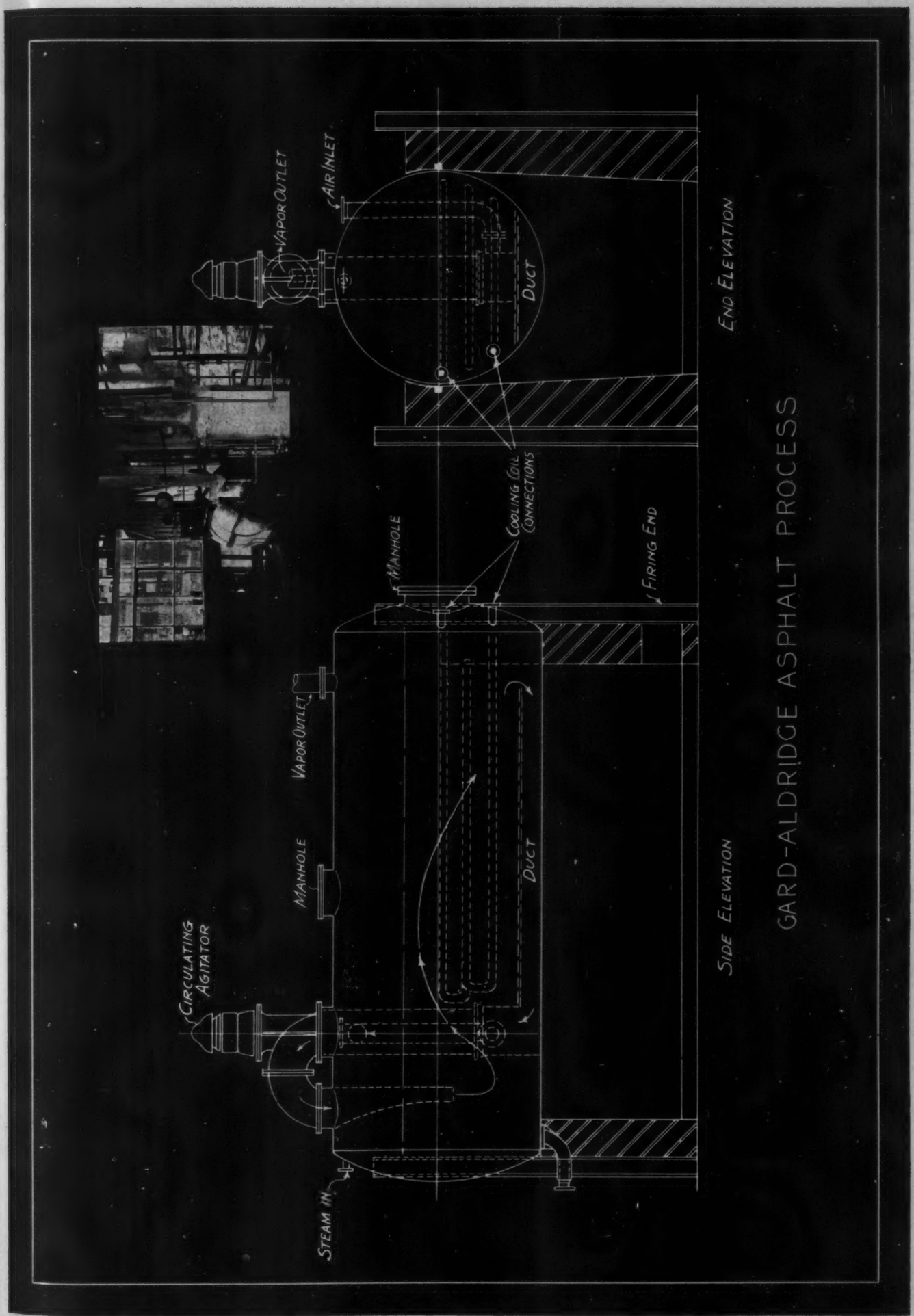

GARD-ALDRIDGE ASPHALT PROCESS
SIDE ELEVATION
END ELEVATION
CIRCULATING AGITATOR
MANHOLE
VAPOR OUTLET
DUCT
STEAM IN
MANHOLE
COOLING COIL CONNECTIONS
FIRING END
VAPOR OUTLET
AIR INLET
DUCT

FIGURE 1

tating mixers are placed above the throat to increase the contact time between the air and oil before discharge at the inside end of the shell still.

A suction duct, on the bottom of the still, extends from the circulating agitator inlet to the opposite end. This establishes a circuit which eliminates any dead areas, and forces the oil over a restricted space along the still bottom, thus obtaining maximum heat exchange, and thereby reducing the time required to reach oxidizing temperature. The circulating stock passes around cooling coils through which a cold, light gas oil is pumped at any desired rate for controlling the temperature of the charge.

The still is charged and fired in the usual manner and the temperature of the charging stock is increased as quickly as possible to the operating maximum, air and top steam being introduced as the proper temperatures are reached. The forced temperature rise is made possible because of the rapid oil circulation along the still bottom. When operating temperature is reached, the fires are "cut" and cooling oil circulation is started through the interior coils. By means of this circulation of cooling oil, the operating temperature can be maintained constant to the end of the run. This eliminates the necessity of "coasting" along on temperature. Complete advantage is taken, with safety, of the more rapid oxidation rate obtainable at higher temperatures.

A study of the data obtained by operating the 10 x 20 commercial size unit disclosed that the Gard-Aldridge process could be further improved by reduction of running time and air consumption. It was therefore, decided to construct a pilot plant exactly to scale in comparison with the 10x20 unit. Although apparently a simple procedure, several months of experimental work were required before a circulating agitator with the desired characteristics was developed. Since this was accomplished, a number of test runs have been made with consistent results which show that running time can be greatly reduced and that the character of the finished product is superior to the product obtained by the usual methods.

Figure 3 is a photograph of the pilot plant which is complete with blower, cooling system, vapor condenser, and boiler. The unit is so constructed that the circulating rate and the air-oil ratio may be varied for the determination of optimum conditions for any charging stock.

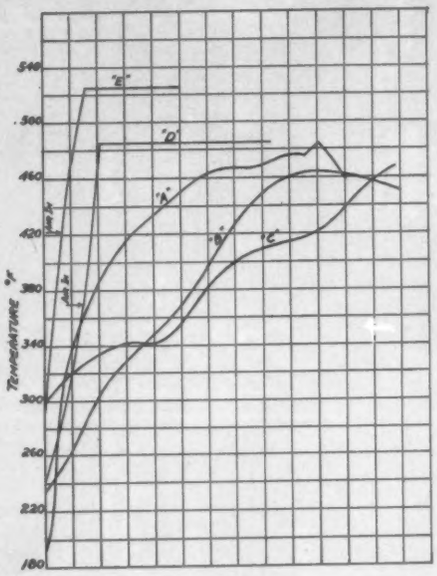


FIGURE 2

Time-temperature curves for various plants. "D"—Gard-Aldridge Process, commercial plant. "E" — Gard-Aldridge Process pilot plant.

The composite curves, Figure 2, graphically illustrate present day commercial operation as compared with the Gard-Aldridge process. Temperature is plotted against time, and the end of each curve is at the number of hours required to produce test stock, or coating with a melting point of 220°F. and a penetration of 18. Curves "A," "B," and "C" are actual normal runs taken from the control charts of three roofing manufacturers. It is interesting to note the quick rise to top temperature of the Gard-Aldridge process, and the uniform temperature during runs.

In addition to the manufacture of standard specification products, it is apparent that products having unusually high melting point and penetration characteristics can be made. A recent run with 8½ hours blowing time resulted in a product which tested as follows:

Melting point	291°F.
Penetration . ....@ 32°F.	26
Penetration . .....@ 77°F.	28
Penetration . .....@115°F.	31
Ductility	1
COC Flash	475°F.
PM Flash	450°F.
Soluble CS_2	99.71%
Soluble CCl_4	99.71%
Soluble 86° Naphtha	68.00%
Fixed Carbon	15.00%

To one familiar with oxidized products, the tests shown above are extremely unusual. Penetration tests are remarkable, there being a difference of only five points between 32°F. and 115°. The solubility tests are significant, especially that in petroleum naphtha when taken in consideration with the melting point. The ductility considered with high melting point is good. In making this test, it was interesting to note that the product did not snap off suddenly, but drew down to a point before breaking. It is believed that this characteristic can be improved.

The Gard-Aldridge process is adaptable to the addition of fillers with the base stock because of the extreme mixing action by the circulating agitator. This feature may also be taken advantage of in blending stocks to produce other than standard specification products.

The wide field of operation, as covered by the Gard-Aldridge patents issued and pending, will eventually solve many problems in regard to asphalt oxidation. With the information thus far obtained, a program of experimental work has been outlined for the pilot plant. The results obtained from these experiments will be presented in an article at a later date.

The Girbotol Purification Process

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Research Engineer, The Girdler Corporation

SEPARATION of hydrogen sulphide or carbon dioxide from gas mixtures is accomplished by the Girbotol process (patented) which employs organic bases, amines, as absorbing agents. Two applications of the process are of particular interest to the oil and gas industry; the removal and recovery of hydrogen sulphide from natural and refinery gases, and the separation of carbon dioxide from hydrogen used for hydrogenation of oil.

The operation of the process is based upon the discovery that aliphatic amines have a strong affinity for acid gases such as hydrogen sulphide and carbon dioxide at or near atmospheric temperature, but at higher temperatures the affinity drops off rapidly and the gas is expelled.

The reversible reaction may be represented by the equations

$$2RNH_2 + H_2S \rightleftarrows (RNH_2)_2.H_2S$$
$$2RNH_2 + CO_2 + H_2O \rightleftarrows (RNH_2)_2.H_2CO_3$$

where R represents an aliphatic organic residue. The reaction proceeds to the right at low temperatures, to the left at high.

It is therefore possible to operate the process in a continuous cycle, absorbing acid gas from a gas stream at atmospheric temperature and expelling it at another point in the cycle by raising the temperature of the absorbent.

A number of amines are applicable as absorbents. Several of those which are available commercially and which have been employed in plants using the process are listed in Table I. Each is particularly well adapted for certain applications. Because the amines are strong bases and freely soluble in water, large volumes of acid gas may be removed per volume of solution circulated. The efficiency of the process is therefore high.

OPERATION

The cycle and equipment employed in the process are almost identical with those of a gasoline absorption plant (Figure 1). Gas to be treated flows up through a bubble tower of suitable size called the absorber. Amine solution, at atmospheric temperature, enters the absorber and flows down the tower from tray to tray picking up the acid gas. Purified gas leaves the absorber at the top.

Rich amine solution, saturated with acid gas, is pumped through heat exchangers, where its temperature is raised to 190°-200°F, and into the upper part of the reactivator, which also consists of a bubble tower, containing in its base a tubular reboiler section and at the top a reflux condenser. The amine solution, flowing down the tower, is heated to 215°-220°F. by steam rising from the boiling solution in the reboiler section, and the acid gas is expelled and flushed out by ascending vapors. The acid gas leaves the reactivator saturated with water vapor at 190°-200°F. and flows through the condenser where it is cooled by water and the steam condensed. The condensate is returned to the reactivator. Hot, lean solution, stripped of acid gas flows from the base of the reactivator to a pump, thence through the exchangers in counter current relation to the cold, rich solution. From the exchangers the solution passes through water coolers, and finally back to the top of the absorber. By proper design the plant may be made entirely automatic, requiring only casual supervision.

HYDROGEN SULPHIDE

Separation of hydrogen sulphide from hydrocarbon gases is accomplished exactly as described above. The gases may be treated at high or low pressure with equal success, but gas under pressure is purified more economically because

smaller towers are required and larger volumes of hydrogen sulphide are removed per gallon of solution circulated. The process is particularly well adapted for purifying gas containing a high percentage of hydrogen sulphide. The rate of reaction in the absorption stage is so rapid that complete stripping may be obtained in a single tower. One plant is washing natural gas containing 1500 grains of hydrogen sulphide and effecting better than 98 percent removal consistently. Because an equeous absorbing solution is employed no hydrocarbon constituents are removed from the gas if the physical conditions of temperature and pressure are controlled. This makes it possible to apply the process for the purification of wet gas before the extraction of gasoline and results in lower subsequent treating costs to purify the gasoline.

The hydrogen sulphide which is recovered in concentrated form may be treated in a number of ways. In instances where quantities are small and the sulphur has no value, the H_2S gas may be burned in a stack or under the boiler. In other cases the hydrogen sulphide may be treated to produce sulphur, for example, by oxidation in a Claus kiln or by interaction with sulphur dioxide produced by combustion of a portion of the hydrogen sulphide

$$2H_2S + SO_2 \rightarrow 2H_2O + 3S.$$

Considerable experimental work by a large number of companies has been carried out on this reaction and a number of refinements have been made.

The most recently proposed method for utilization of the hydrogen sulphide, especially in a refinery, is as raw material, in place of brimstone, for the manufacture of sulphuric acid. One million cubic feet of gas containing 450 grains of hydrogen sulphide per hundred cubic feet carries sufficient sulphur to produce one ton of 66° Be. sulphuric acid. A large refinery can therefore profitably produce its acid requirement from its own gas. Several such installations are now under consideration.

One unusual application of the purification process is in conjunction with the storage of gas in a group of abandoned wells. A utility company which must pipe natural gas several hundred miles to a large community through a line too small for peak demand, has adopted the plan of bringing in excess gas during the summer months and storing it in several old wells close by. This exhausted gas dome originally produced sour gas, and consequently the sweet gas pumped into this dome when removed contains H_2S, and the gas must be purified when it is removed for distribution.

It was expected that after several years' use the wells would be washed free of sulphur and this is proving to be the case. A fresh supply of gas has been brought in each summer during the past five years. During the first winter of withdrawal, the hydrogen sulphide content averaged 500 grains per hundred cubic feet; in this, the fifth winter the content has dropped to 70 grains.

CARBON DIOXIDE FROM HYDROGEN

Large volumes of industrial hydrogen are now prepared by reacting methane with steam at a high temperature and oxidizing the resulting carbon monoxide to carbon dioxide with an additional quantity of steam at a lower temperature. The reactions are

$$CH_4 + H_2O \rightarrow CO + 3H_2$$
$$CO + H_2O \rightarrow CO_2 + H_2$$
$$CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$$

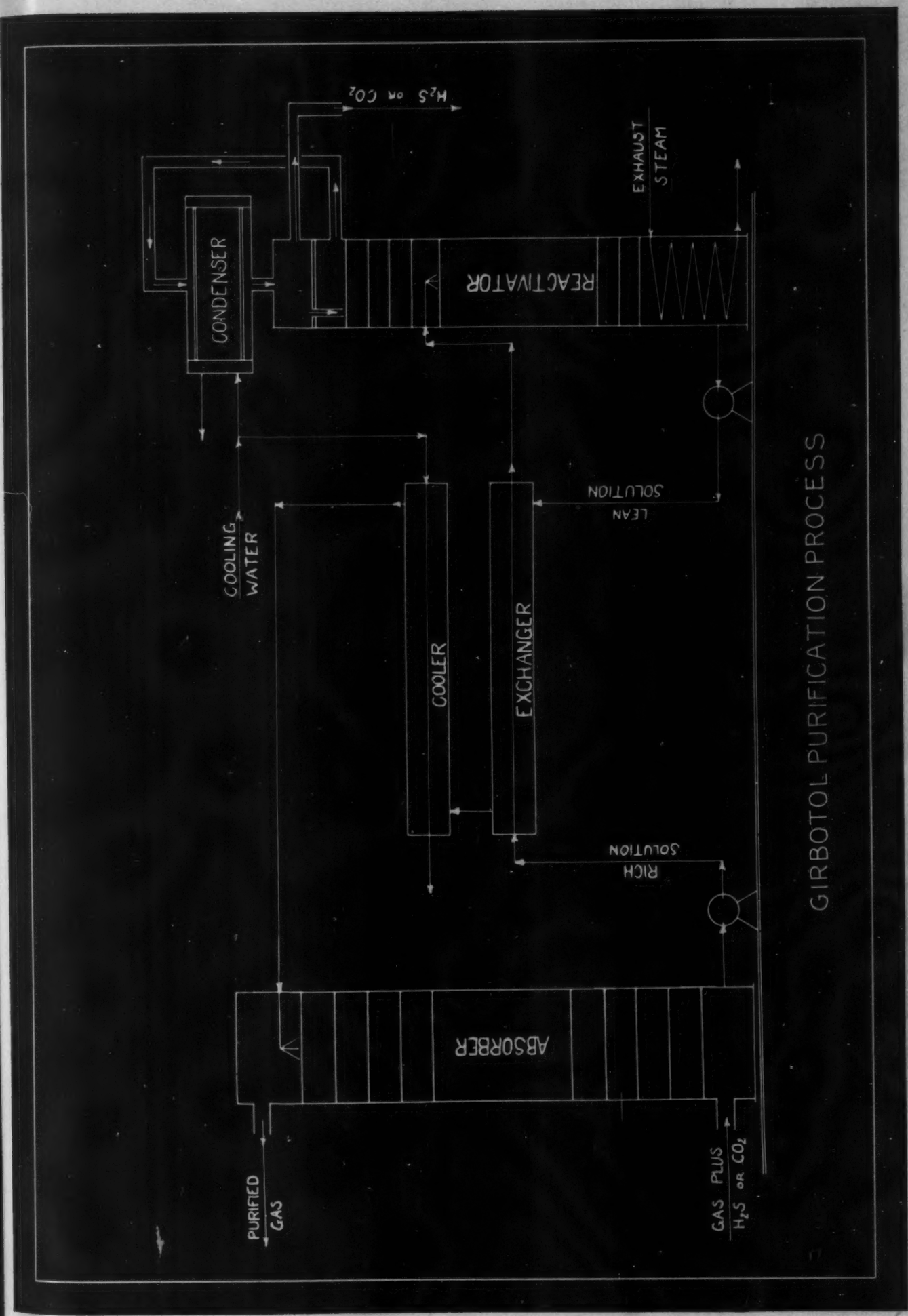
The resulting gas mixture contains 18-20 percent carbon dioxide and practically no carbon monoxide.

In most instances the Girbotol process will remove the carbon dioxide more economically than will the older, water wash process. Separation with an amine solution may be carried out at atmospheric pressure, whereas the solubility of carbon dioxide in water is so low that the gas must be compressed before it is washed. Even though the hydrogen must be subsequently compressed, there is a saving of 18-20 percent in compression cost with the Girbotol process because of prior removal of carbon dioxide. Of greatest importance, the carbon dioxide may be completely eliminated with relatively small volumes of amine solution, while tremendous volumes of water must be employed for comparable purification. Before use, the water must be decarbonated and deaerated.

One installation of the process for washing carbon dioxide out of 7,500,000 cubic feet of hydrogen has been in successful operation since 1931. During the first few months, considerable corrosion occurred in certain parts of the equipment, but this difficulty was traced to corrosive impurities introduced into the hydrogen from the river water used for cooling the hydrogen. Indirect tubular coolers were installed and this difficulty eliminated.

TABLE 1

Commercial Name	Triethanolamine	Monoethanolamine	Dapol	Methicol
Structure	$N(CH_2CH_2OH)_3$	H_2CNH_2 | H_2COH	H_2CNH_2 | $HCOH$ | H_2CNH_2	$H_2CN(CH_3)_2$ | $HCOH$ | H_2COH
Nitrogen Content	9.4%	22.9%	31.1%	11.8%
Boiling Point, °C	208 (10 mm)	172	119 (4 mm)	217
Strength Water Solution Normally Employed	50%	15%	30%	15%
Acid Gas Capacity Solution ft.³/gal.	5.5	4.0	11	2


GIRBOTOL PURIFICATION PROCESS
H_2S OR CO_2
EXHAUST STEAM
CONDENSER
REACTIVATOR
COOLING WATER
LEAN SOLUTION
COOLER
EXCHANGER
RICH SOLUTION
ABSORBER
PURIFIED GAS
GAS PLUS H_2S OR CO_2

Technical Control of

Percolation Filtration

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Technical Division, Attapulgus Clay Company

THE percolation filtration process, wherein the material to be purified is passed through a stationary bed of granular adsorbent, was probably first used in this country by Pennslyvania petroleum refiners about 1890. The contact filtration process, involving intimate and vigorous agitation of a finely divided adsorbent with the material to be purified, was first employed by John Fordred, an English chemist, whose work is revealed in a series of English patents dating from 1867 to 1868.[1]

Recent publications on petroleum refining by various methods of solvent treating frequently have referred to attractive savings in manufacturing costs through elimination or reduction in use of clay. Such claims are particularly impressive to those refiners whose present treating processes are excessive in cost, through lack of technical control and uneconomical balance of refining methods. Thus, while it may be physically possible to use large volumes of solvent to produce a finished oil in one step by solvent refining, the accompanying low yield of treated oil and excessive processing cost would probably make the addition of a clay refining step justified from an economic standpoint alone. The merits of clay treatment, however, can not be confined to the function of decolorization. Clay treatment by percolation filtration often has as its primary function, the improvement of stability, demulsibility, sludging characteristics, cast or bloom, dielectric strength, and odor and taste of the oil. When this is the case, advantages of percolation filtration should not be overlooked.

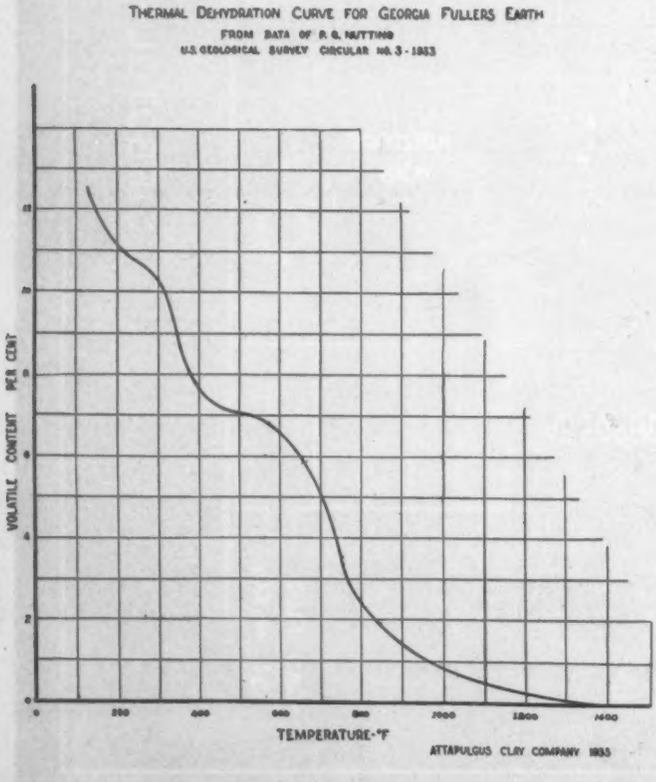
THERMAL DEHYDRATION CURVE FOR GEORGIA FULLERS EARTH
FROM DATA OF P. G. NUTTING
U.S. GEOLOGICAL SURVEY CIRCULAR NO. 3 - 1933
VOLATILE CONTENT PER CENT
TEMPERATURE-°F
ATTAPULGUS CLAY COMPANY 1935

FIGURE I

The study of any one process should consider the raw material to be processed and the product desired supplemented by cost analysis to insure the proper economic balance between all available refining methods.

It is the purpose of this article to assist the refiner in applying the percolation process to best advantage by means of control methods outlined herein.

Percolation filtration is distinctly a low cost treating process. Perhaps the most important phase of the operation from a cost standpoint is the initial burning and subsequent revivification of the clay. Application of well-known principles of operation and utilization of the testing methods described herein should result in substantial increase in clay efficiency over the average.

A.—DISCUSSION OF RAW CLAY BURNING

The raw clay as received at the refinery contains adsorbed water, water of constitution and water of crystallization. Reference to a typical thermal dehydration curve for bleaching clay (Figure I) provides little, if any, evidence from which the nature of the water clay association can be established. It has been found that removal of sufficient moisture to give a clay of 3.0 to 5.0 percent volatile content produces the optimum adsorbent, which volatile con-

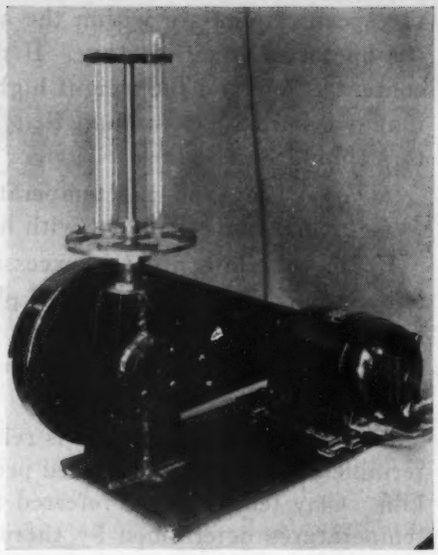

FIGURE II

Apparatus for volume-weight determination.

tent is readily attainable on raw clay in modern clay burning equipment at temperatures below the fusion point of the clay.

The manner of removal of moisture in raw clay is of paramount importance. It has been found that actual clay temperatures in excess of 1100°F. or exposure to gas temperatures of greater than 1300°F. results in a loss of clay efficiency upon subsequent reburnings. While it is possible to obtain higher initial filter yields by burning at higher temperatures, the loss in clay efficiency upon revivification is greater. There does not seem to be a sound explanation for this phenomena. However, it is known that there is a definite change in the physical structure of the clay upon revivification, as exhibited by its increased hardness and the fact that it will not gradually disintegrate in water as will the raw clay. Evidently the manner in which the gel structure is modified by the initial burn greatly affects its permanence and physical resistance.

As a standard practical operation, the maintenance of new clay at a temperature of 850 to 900°F. for 15 minutes results in the best operation.

The following test determines all the volatile matter in a clay:

TEST 1—DETERMINATION OF THE VOLATILE CONTENT OF A CLAY

Apparatus

Porcelain or platinum crucible (ignited to dryness).
Electric muffle furnace.
Dessicator.

Procedure

Weight exactly 2 grams of a representative sample of the clay into the crucible.
Place crucible and clay in the electric oven (1800°F. temperature) for 30 minutes.
Remove to dessicator until cold.
Weigh and ignite until to constant weight.

Results

Calculate loss of weight as per cent volatile matter.

$$\frac{\text{Loss in grams} \times 100}{\text{Weight of original sample}} = \text{per cent volatile matter.}$$

Note (Exception)

When the clay is wet or larger than 30/60 mesh, 5 grams of clay are used.

Routine Accuracy:

Results should check within .2 of one percent volatile matter.

PLOT OF VOLUME WEIGHT IN POUNDS PER CUBIC FOOT VERSUS CLAY NUMBER FOR CLAYS BURNED IN THREE COMMON TYPES OF REFINERY CLAY KILNS UNDER CONTROLLED CONDITIONS

	AVERAGE VOLATILE CONTENT	AVERAGE PERCOLATION EFFICIENCY—NO.1 CLAY=100%
DIRECT FIRED HEARTH	4.0%	52 %
DIRECT FIRED ROTARY	8.8%	49 %
INDIRECT FIRED HEARTH	2.5%	67 %

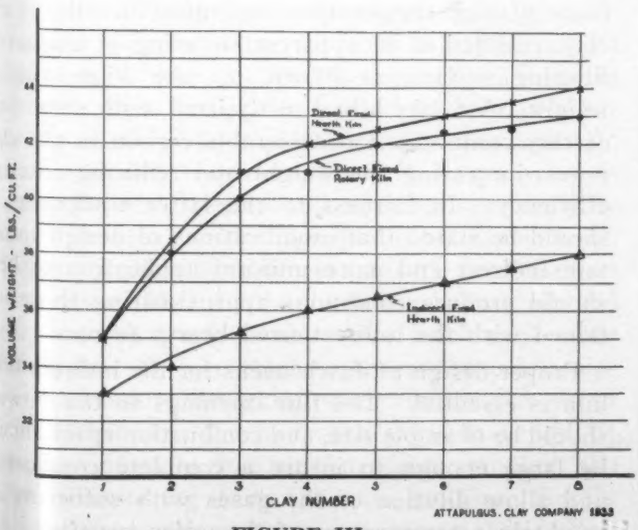

FIGURE III

B.—DISCUSSION OF USED CLAY BURNING

The burning of used clay should accomplish the reduction of moisture content and removal of hydrocarbons and other organic matter without destruction of the active adsorbent structure.

The clay to be burned must contain an economic minimum of combustible matter (see Clay Washing). In the laboratory, under controlled conditions, it has been found possible to retain, for a number of burnings, nearly all of the original efficiency of the clay by careful control of burning temperatures and clay washing. In transferring these studies to plant operation, it has been found that best revivification from a cost standpoint can be obtained when the following conditions are complied with:

a. Oil content of washed clay charged to kiln .....1.0 percent or less
b. Maximum burning temperature of clay..1100°F.
c. Maximum temperature of gas in contact with clay .....1300°F.
d. Time clay is at temperature.....15 minutes
e. Furnace atmosphere .....oxidizing

The volume weight and volatile matter tests may be used as a quick method of determining the quality of the burned clay. The following test has been developed for obtaining the apparent density of clay (volume weight). Mechanical operations and stand-

ardization of practice promote accuracy and save time.

TEST 2—DETERMINATION CLAY VOLUME

Apparatus:

100 cc. graduated cylinder
Tamping device (see photograph, Figure II)
Strokes of tamp plate (up and down) = 150 per minute (1/16-inch clearance).

Procedure:

Clamp cylinder in holder of machine and fill from a constant height with 100 cc. of the clay to be tested.
Run the machine for five minutes to tamp sample. Then add sufficient make-up clay to refill cylinder to the 100 cc. mark, being careful not to disturb the graduate. Then determine net weight of clay in graduate to 0.1 gram accuracy.

Results:

Weight of clay in grams x .624 = lbs./cu.ft. of clay.

Routine Accuracy:

Results should check within 0.5 lbs./cu.ft.

Note:

The above test is to be interpreted only as the apparent volume weight of a clay. It was designed to yield quick, reproducible results and should not be used for real density determinations. In order to eliminate the use of more than one conversion factor (.624) the cylinder is refilled to the 100 cc. mark with untamped clay as above.
The so-called "Full Volume Weight Test" adopted by some laboratories, wherein the clay is allowed to fall from a constant height into a 100 cc. graduate without tamping, is usual for estimating the actual weight of clay in plant filters.

It has been found that the high quality natural clays of the general Georgia-Florida type should possess the following inspections to obtain high efficiency:

Clay No.	Volatile Matter Percent	Volume Weight Lbs./cu.ft.
1 (raw clay after burning)	3.0 — 5.0	32.0 — 34.0
2	2.0 — 2.5	33.5 — 35.5
3	1.5 — 2.5	34.5 — 36.5
4	1.5 — 2.5	35.5 — 37.5
5	1.5 — 2.5	36.0 — 38.0
6	1.5 — 2.5	37.0 — 38.5
7	1.5 — 2.5	37.5 — 39.0
8	1.5 — 2.5	38.0 — 39.5

It is necessary that both the volume weight and volatile matter tests conform to specifications. If the specifications are within the above range, burning operation is satisfactory. If the volatile matter content is low and the weight high, the indication is that overburning exists and that the following factors should be checked:

a. Clay and gas temperature.
b. Time of contact with heat.

If the volatile content is excessive, the indication is that underburning is taking place. The survey in this case should cover the above mentioned factors and in addition investigation of the conditions of burning atmosphere.

The foregoing information is relatively easy to determine and should be obtained periodically on every kiln. Clay temperatures referred to above are those temperatures determined by thermocouples actually in the moving clay and not readings secured by thermocouples imbedded in a dead clay space. Readings obtained in the latter manner have been found to vary as much as 150°F. from the true clay temperature. Figure IV shows how thermocouples attached to the rabble arms of a hearth furnace may be brought in direct contact with the clay.

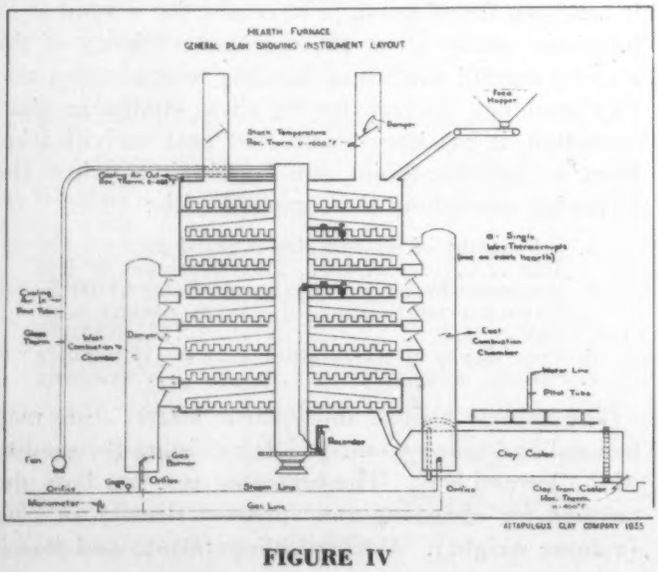

FIGURE IV

C.—SELECTION OF BURNING EQUIPMENT

To obtain the desired conditions for burning used clay, as heretofore specified, facilities should provide the following:

a. Large volume of low temperature flue gas as the heating medium.
b. Indirect firing.
c. Close control of temperature.
d. Control of clay thruput rate.
e. Control of air mixture in flue gas.

The indirect fired hearth furnaces seem to meet the foregoing requirements.

An example of the typical clay products secured from the different types of clay burning equipment is shown by Figure III. In one instance a direct fired hearth kiln with burners on each hearth, gas flame of high temperature impinging directly on the clay, resulted in an apparent sintering of the active filtering surface, as shown by the high volume weight. A rotary kiln directly fired, with short time of clay contact, left considerable carbon in the clay pores, increasing the weight and reducing filtering efficiency. In fairness to the latter equipment, it should be stated that modifications of design to obtain indirect and more uniform application of heat should produce conditions approximating those obtained with the indirect fired hearth furnace.

Proper design of dutch ovens for the indirect fired kiln is essential. The flue openings to the furnace should be of ample size, and combustion space should be large enough to insure a complete combustion and allow dilution of the gases with sufficient air to obtain a temperature of the order specified.

Trends in Chemical Refining Practice

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The Globe Oil & Refining Company

THE trend of chemical refining practice is apparently a gradual withdrawal from the older, proven methods toward new ideas and new methods which promise simpler and less expensive operation. The question of treating costs is becoming, more and more, the criterion upon which is based the success of any proposed change of methods. In one sense, this condition is to be encouraged, since it provides incentive toward new discoveries and at the same time tends to eliminate waste, but on the other hand it may lead the refiner into pitfalls, the egress from which may be tedious as well as expensive.

The industry has seen the introduction of new treating processes such as the Gray tower and the Lachman zinc chloride vapor phase units for cracked gasoline. These, and others well understood in refining circles, have thus far stood the test of time and have exhibited advantages over previous methods. The same may be said of the use of selective solvent refining in the lubricating oil industry, and of the introduction of certain new gasoline sweetening processes now in use. The increasing use by refiners of gum and color inhibitors for cracked gasolines in lieu of treatment, or as an adjunct to treatment, bids fair to sweep the industry clean of preconcieved ideas as to what constitutes good gasoline.

To day we are concerned with the treatment and sweetening of two main types of distillates, cracked distillates and straight-run distillates. Straight-run products have long been manufactured and treated, and ordinarily, little difficulty has been encountered with them. Treatment for color and odor usually consists of a light sulphuric acid wash followed by neutralization, or no treatment at all except for removal of hydrogen sulphide by caustic soda, hypochlorite, ammonia, soda ash, or other alkaline reagents. When it is necessary to sweeten the straight-run distillate, either sweetening by doctor (plumbite) or by hypochlorite has found favor.

When considerable hydrogen sulphide is evolved in the fractionation of straight-run gasolines, it has been found advisable to remove as much as possible of it within, or just behind, the condensing equipment and before the gasoline enters the run down tanks. Otherwise, the hydrogen sulphide would be slowly oxidized to free sulphur upon standing, the sulphur dissolving back into the gasoline. Simply washing the condensed gasoline stream with clean water will remove hydrogen sulphide when present in relatively small amounts, or will in any case inexpensively remove a portion of the total H_2S present. A light caustic soda scrubbing is necessary when the percentage of hydrogen sulphide is larger. If it is planned to use either water or light caustic within the condensing system, one must beware of plugging the condenser. This plugging, or scale formation is due in most cases to the formation of calcium carbonate from the water being used. The reason is that temporary hardness is removed from raw water on being subjected to condenser temperatures. The effect is decomposition of bicarbonates to form less soluble carbonates, and to some extent, hydrolysis of carbonates and sulphates to form less soluble basic salts and hydroxides. The cause being known, the remedy is simple: i.e., the contacting water should be either treated water, or plant cooling water from which the temporary hardness has already been removed. Such water is usually available in large quantities in most refineries.

The water or caustic contacting system outlined above will, in addition to removing hydrogen sulphide from the gasoline, prolong the life of the condensing and reflux pumping equipment by neutralization of acidic hydrogen sulphide and of hydrochloric acid which would otherwise attack the metal of the system. Hydrochloric acid is the worst offender in this connection, slowly eating away iron parts and forming iron chloride. The insidious nature of this corrosion is brought to light when one considers the belief that when iron chloride is once formed, the latter is then attacked by the hydrogen sulphide present, giving iron sulphide, and liberating the hydrochloric acid which is then free to dissolve more iron. The presence of hydrochloric acid in the first place is due to the presence in the crude oil of magnesium chloride brine which hydrolyzes, forming the weak base magnesium hydroxide and the strong acid hydrochloric at elevated temperatures and in the presence of water vapor. Other methods are available in fighting hydrogen sulphide and hydrochloric acid, the classic example being ammonia or ammonium hydroxide.

In some cases, the hydrogen sulphide treating problem finds its way deeper into the heart of the refinery. For example, the cracking still begins to show evidence of corrosion within the tubes. Usually, this condition

is the result of the breaking down of sulphur compounds in the charging stocks into hydrogen sulphide at the high temperatures and pressures experienced within the cracking equipment. The author has seen as much as 50 grams of hydrogen sulphide per barrel of (H_2S free) charging stock evolved in this manner. Unquestionably, still higher figures have been reported elsewhere. The solution of this problem is not difficult, but it encounters opposition from more than one source because of the nature of the "cure."

One solution of the difficulty can be visualized when it is explained that the stability of the sulphur compounds in the charging stocks can sometimes be controlled by the operating conditions under which the charging stocks are manufactured. These less stable sulphur compounds may be concentrated in one or more fractions of the material later separated into cuts during operation. A study of these fractions will reveal the position of the guilty individuals. As an example, it has been noticed that operation of vacuum tower equipment under conditions to produce a heavy, solid pitch from mainly cracked material, produced some gas oils containing large amounts of unstable sulphur compounds, while operation of the tower on the same crude, but under conditions producing a less viscous residuum, gave gas oils, the sulphur compounds of which were much more stable. The chemical composition of the crude itself, of course, plays an important part in the final characteristics of the cracking stocks.

In some cases, corrosion has been eliminated and hydrogen sulphide reduced to negligible quantities by the introduction of a hydrated lime-gas oil slurry into the charging stock behind the hot oil pump and before the preheating equipment. It should not pass through the hot oil pumps because of the danger to the pump packing and other parts.

The treatment of refinery gases and natural gases for the removal of hydrogen sulphide has been the subject of a good many papers and for that reason, will not be discussed here. It is sufficient to point out that should any dry (gasoline free) gas be used in internal combustion engines such as those used in refinery compression plants, or should it be burned under the stills or boilers, the hydrogen sulphide content should be reduced to a reasonable figure, dependent upon the circumstances, to prevent the formation of sulphurous acid from the products of combustion of hydrogen sulphide. The writer has seen sulphurous acid formed in large enough quantities while H_2S containing gas was being burned under tube stills, to condense and trickle down the outside.

Thus far, we have been discussing mainly the treatment of straight-run products. Today, however, the refiner is also necessarily interested in the treatment of cracked products. It has been previously mentioned that with straight-run gasoline sweetening by means of plumbite or hypochlorite is satisfactory. On the other hand, sweetening cracked gasoline with hypochlorite solutions is so difficult that it is not used generally in this country. Unsaturated hydrocarbons found in cracked gasolines are subject to chlorination and to other less obvious reactions when brought into contact with either sodium or calcium hypochlorite. The resulting sweet gasoline often exhibits poor color stability and other alarming characteristics. Furthermore, simply the blending of hypochlorite sweetened straight-run with doctor-sweet cracked gasoline is often enough to cause difficulties of stability. The author has proven to his own satisfaction that at least some cracked gasolines can be sweetened with hypochlorite by the exercise of great care in handling and in the control of caustic concentrations, but the fact remains that "hypo" seldom is used on cracked products.

Sodium plumbite, or doctor solution seems to be capable of satisfactorily sweetening both straight-run and cracked products and is widely used for both purposes. Here again, however, if we go beyond that statement and emphasize the word "satisfactorily" and fail to qualify the term "cracked", we are treading on thin ground and can expect to find ourselves plunged into a quagmire of doubt and indecision. The difficulty arises from the fact that doctor solution is a strongly caustic solution. Cracked gasolines contain what we glibly call natural gum inhibitors. They are, insofar as we know, phenolic compounds of unquestionably complex nature, probably similar, in their reactions, to the artificial phenolic compounds now on the market as gasoline antioxidants. Cracked gasolines also contain naphthenic acids and other organoacidic bodies. All of these compounds are attacked by caustic soda alone or in the form of doctor solution. The net result is at least their partial removal from the gasoline, being precipitated, or dissolved in the caustic solution as the sodium salt of the organic acid or phenol.

The loss of natural inhibitor goes unnoticed when sweetening well treated gasoline since either most of the inhibitor has already been removed during the treating process or the gasoline is so far above specification as to storage stability and gum stability that the loss is not noticeable. However, when attempting to sweeten poorly treated or simply untreated pressure distillates the effect is brought forcibly to attention. A sample of pressure distillate containing its natural gum inhibitors can be either washed with caustic soda or sweetened with caustic plumbite solution, where upon the induction period (a function of its storage life) takes a precipitous drop and at the same time, the potential gum content of the distillate rises sharply. This condition can be remedied by the addition of artificial anti-oxidants after the caustic treat, preferably after a dilute acid wash to remove last traces of caustic. Caustic soda, then, is the enemy of phenolic gum inhibitors, both natural and artificial. Fortunately, there are other alkalies, such as sodium carbonate or lime which do not exhibit so strong a tendency to attack inhibitors.

While still on the question of sweetening cracked gasolines, it will be well to consider some other problems that have arisen. Some sweetening plants successfully

sweeten a blend of treated gasoline with straight-run and recovery gasoline taking a finished product ready for tank cars off the sweeteners. Other plants sweeten cracked and straight-run products separately. In the light of increasing knowledge concerning storage stability, actual gum contents, and the effect of caustic reagents on cracked gasolines, the second method of operation presents a greater opportunity for careful control. One plant recently began having difficulties with the sun stability of their straight-run gasoline, a condition which was surprising to them and entirely unexpected. They had been sweetening the straight-run and cracked gasolines separately, but had been indiscriminately mixing the "doctor" from both sets of treaters. Investigation showed that the trouble was caused by impurities, unfilterable solids, from the cracked gasoline doctor, thought to be complex organic soaps. These formed a colloidal solution in the straight-run gasoline and broke down in the form of a brownish gray cloud on exposure of the gasoline to sunlight. The solution of the problem lay in the segregation of the cracked and straight-run doctor solutions and improvement on the condition of the cracked gasoline doctor. Further improvement in the storage life of the cracked gasoline was brought about by separating from the cracked doctor, the lead sulphide formed, followed by blowing and "building" the latter with fresh litharge and caustic, and then blending the two together again. This procedure eliminated the necessity of blowing the spent doctor solution. The reason for the improvement was undoubtedly that heating and blowing had formerly tended to destroy natural gum inhibitors soluble in the spent doctor, whereas the new method preserved some of them in a form that they could be reabsorbed into fresh cracked gasoline. This experience also suggested the possibility of recovering from cracked fractions their natural inhibitors, and gave impetus to further work along this line.

Altogether, the increasing use of artificial anti-oxidants have brought up questions concerning gasoline that have lain dormant for a number of years. Refiners have treated to a copper dish gum specifications for so long that they are, for the most part, reluctant to completely ignore this specification. As a matter of fact, recent investigation has indicated that the copper dish gum, while not in itself a reliable criterion, can still be quite useful in grading a gasoline when used along with some of the newer specifications, such as preformed gum, potential gum, and induction period. A good many fresh, untreated, sour pressure distillates exhibit an entirely satisfactory induction period and preformed gum content but show copper dish gum ranging into hundreds of millegrams per 100 cubic centimeters. Such pressure distillates, upon contact with caustic solutions as in caustic washing or plumbite sweetening often lose their storage stability as indicated by a drop in the induction period. Such pressure distillate could be expected to "go off" in storage or in the customers tanks if it inadvertently came into contact with caustic solutions. On the other hand, most well treated pressure distillates with no better tests than raw pressure distillates mentioned except for the copper dish specification, are not materially affected in any respect by contacting with caustic solutions.

The ramifications of some of these new problems that face the refiner are such that it is incumbent on him to consider carefully all angles of the question before deciding upon new methods of treating or refining that appeal to his financial program. A thorough investigation will prove or disprove the advisability of the proposed steps. Speaking of the question of artificial gum and color inhibiting, it is unquestionable that if handled correctly such procedure as a secondary step to treating, or in some cases, as a substitute for treating, will work out to the advantage of the refiner. The primary precautions are that the refiner either manufacture a product good enough to stand alone before inhibiting or else make certain that his inhibited product will stand up under any and all circumstances to which it might be exposed.

Distillates can be sweetened without recourse to caustic agents. An example of such treatment is the Hoover process, which is a dry contact method using copper chloride as active agent. The chloride is deposited upon an inactive, adsorptive surface such as that possessed by some infusorial earths, and the hydrogen sulphide free sour gasoline is passed through a body of this reagent.

The following reaction takes place:

$$\begin{matrix}RSH\\RSH\end{matrix} + Cu\ Cl_2 \rightarrow \begin{matrix}RS\\RS\end{matrix} > Cu + 2HCl$$

Hydrochloric acid and copper mercaptides are formed. To keep the acid on the surface of the clay, and to oxidize the copper mercaptides, oxygen is introduced:

$$\begin{matrix}RS\\RS\end{matrix} > Cu + \tfrac{1}{2}\ O_2 + 2HCl \rightarrow \begin{matrix}RS\\RS\end{matrix} + CUCI_2 + H_2O$$

The final products of the reaction are alkyl disulphides and cupric chloride. Since the copper salt is returned to the clay, the reagent is theoretically never used up.

This is one of the newer sweetening processes, and has been briefly described here only to show the trend of thought in recent developments. It has been used to sweeten distillates of all kinds, and is unique in that it has no noticeable effect on any hydrocarbons other than the mercaptans, which are oxidized to the disulphides, trisulphides, or other similar "sweet" compounds, depending upon the structure of the original mercaptans.

There is still another, and important direction toward which the refiner is turning, forced by competition and by the present economical set up. This is the field of by-products, from the manufacture of compressed industrial and domestic gas, to asphalt and coke specialties, thus taking in the entire range of hydrocarbons found in petroleum. The commercial possibilities are unlimited in this field, with such a promising raw material as crude oil. The world will probably witness the introduction of these and many other petroleum by-products in increasing volume as times passes.

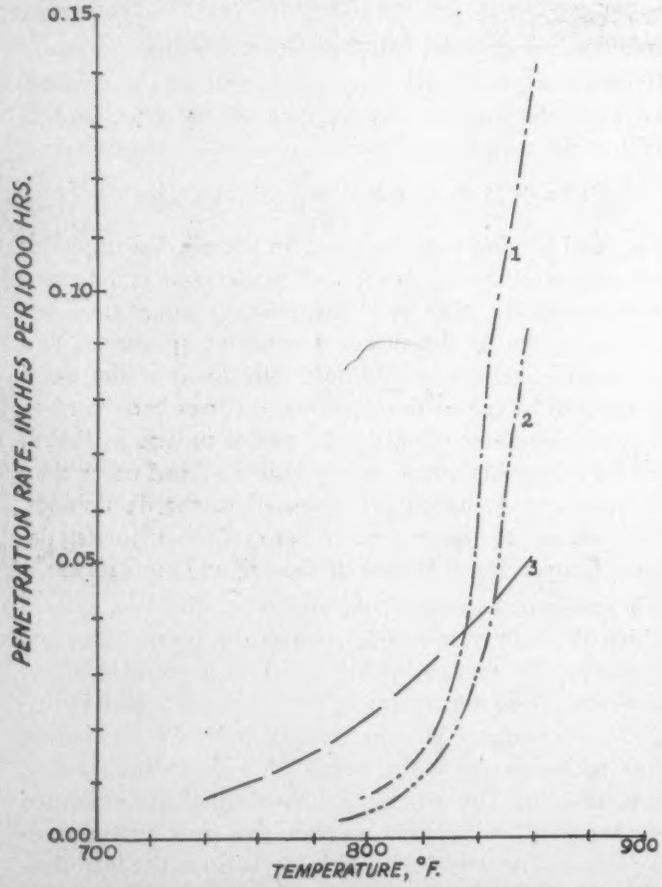
Corrosion in California Refineries

J. C. ALBRIGHT

PART I

IN this series of two articles dealing with methods employed by California refineries in combatting corrosion Mr. Albright has received valuable assistance from the engineering and technical development departments of several of the large West Coast refining companies. The article reflects the opinions of these engineers and technologists and reports on their experience over a period of years and their practices in retarding costly corrosion of refinery equipment. Part 2 of the series will be presented in an early issue. The Refiner wishes to express thanks to those who have so freely given of their time and knowledge in the preparation of this work.

CORROSION as it effects equipment in refineries in California may be placed roughly into three classifications. The first, which is the most troublesome as well as the most expensive, is that encountered while cracking. The second classification embraces corrosion caused by corrosive agents in the stocks charged to the low pressure, low temperature units used in simple distillation or skimming processes. The third can be readily sub-divided into two classifications, one of which covers exterior corrosion of plant pipe lines, and the other the corrosion of condensing and cooling equipment, either tube and shell or atmospheric units, coming into contact with salt or fresh water.



Corrosion rates as found in three widely differently designed cracking stills, each processing a 30° A. P. I. gas oil, each unit being fitted with three-inch tubes.

The factors influencing high temperature corrosion are probably as complex as the mechanism of the reaction, but it appears from information gathered generally the following conditions are the most important:

1. The kind of corrosive agent encountered while cracking.
2. The kind of metals from which the equipment is fabricated.
3. The processing temperatures involved.
4. The concentration of the corrosive agent responsible.
5. The combination of corrosion and erosion caused by the corrosive agents in and the turbulence of the materials being processed.
6. Cyclic stresses or corrosion fatigue.

The opinion of the petroleum engineers is somewhat divided in regard to the kind of corrosive agents encountered while cracking. Naphthenic acid has been held responsible for a number of corrosive conditions found, but the majority of the refinery engineers and metallurgists agree that hydrogen sulfide and other sulfur compounds are the principal agents involved. Because of the fact that sulfur corrosion rates are comparatively negligible when processing California crude through ordinary topping plants, it appears that hydrogen sulfide as such is not present in sufficient quantities to cause much concern. The

presence of hydrogen sulfide in the material while being processed is caused by the thermal decomposition of the sulfur in the oil, which results in hydrogen sulfide and other corrosive sulfur compounds being formed at the elevated cracking temperatures.

The rate of corrosion as it causes deterioration of refinery equipment is controlled largely by the kind of metals used in fabricating vessels and constructing the various parts of the cracking units. Plain carbon steel tubes and vessels, if not protected from the corrosive influence of destructive agents encountered are readily destroyed. Some instances have been found where reaction chambers not so protected had a useful life of only about a year and a half.

A four-inch return bend destroyed by corrosive agents in vapors.

12-inch tee from vapor line showing internal corrosion from hydrogen sulfide.

The effect of temperature upon corrosion appears to be somewhat a controversial subject. Some of the metallurgists and refinery engineers have found that the rates are accelerated by raising the temperature above 800°F. and that it continues to affect the steel more rapidly if a soaking temperature is maintained at approximately 880°F. One engineer reports that the corrosion rate increases almost four-fold during the progressive cracking stage in the still tubes when the temperature is maintained at or above this temperature. His conclusions were drawn from information derived from carefully observed experimental runs through three widely differently designed cracking units, all of which were processing a 30° A.P.I. gas oil. In each case the tubes were three inches inside diameter, and the maximum temperatures were substantially the same.

Conditions in this plant where the rates of corrosion progressed rapidly between 840°F. and 880°F. resulted in a corrosion penetration in some cases of as much as 0.15 inches per 1000 hours operation. He found this rate to actually exist in a unit used as a viscosity breaker to which was charged a heavy residuum containing 1.4 percent sulfur.

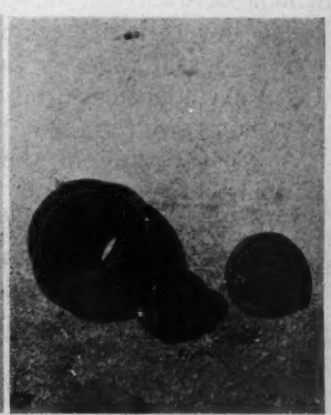
He finds that the increase in corrosion rates may be due to two factors. First, it is very probable that it follows the usual chemical laws, that the reaction is accelerated at high temperatures; and second, that the higher temperatures cause the original inert complex sulfur compounds to decompose to form very corrosive pyrolytic reaction products, such as hydrogen sulfide, sulfur mercaptans, etc. He states also, that temperature not only accelerates the corrosive action of the agents in the oil, but also greatly increases the oxidation rate on the outside surface of the tubes, which latter condition also affects the grain structure of the steel to such an extent that the corrosive agents may penetrate more rapidly with a consequent rapidly increasing penetration at the constant elevated temperatures.

Another engineer who observed cracking units processing a topped crude, found that the corrosion rates rose rapidly at or near 725°F. and reached their peak somewhere near 775°F. Above that temperature, the rate of penetration fell rapidly. To overcome the difficulty encountered in these units, the temperature is raised as rapidly as possible to a point well above the peak and carried it there during the remainder of the run.

To support the penetration rates and peak point of this engineer, Matson (REFINER, Vol. 10, June, 1931, P. 110, "Safeguarding Cracking Operations from Accident") reported that for a given type of charging stock and method of operation, maximum corrosion will occur within a fairly well defined oil temperature range, above and below which the rate of corrosion is considerably less.

Very little information is available concerning the concentration of the corrosive agent responsible for rapid deterioration of refinery equipment. It has been found that all high sulfur crudes are not necessarily extremely corrosive, but an oil with a low sulfur content may be, depending upon whether the sulfur is easily available for corrosion by the cracking process, or whether it is tightly bonded to the molecule of the oil. After about 0.5 percent sulfur content is reached, the type of sulfur compounds and

Section of what was originally a three-inch heavy steel tube, used as a steam line in bubble tower, but corroded to this condition from contact with cracked vapors.



Header bushing and plugs reduced to this condition by corrosion in cracking service. Bushing was originally one-inch in thickness but reduced to one-half-inch.

the pyrolytic products are more important than the sulfur content itself.

Besides being actively affected by temperature, it appears that the rate at which hydrogen sulfide reacts with the metal surfaces of cracking equipment depends upon the concentration of the hydrogen sulfide at the metal surface. According to some engineers, the major factors that effect the amount of concentration of hydrogen sulfide at the metal surfaces of cracking equipment are:

1. The percentage of hydrogen sulfide originally in the charging stock, or formed during the particular cracking operation.

2. The total pressure in the cracking system which directly effects the partial pressure of the hydrogen sulfide of a given volume percent.

3. The velocity and turbulence of the oil or vapors. Apparently high velocities and a large amount of turbulence in the pipe lines to and from the different vessels of the cracking equipment affects the condition or diffusion of hydrogen sulfide at the reacting surfaces, or walls of the tubes and vessels, and also prevents the formation of a protective coating of coke or that of the corrosion product.

4. The nature of the protective coatings artificially applied, or coatings formed by corrosion during cracking operation.

Because of the apparent concentration of corrosive agents, whether they are hydrogen sulfide, naphthenic acid or other corroding agents, several of the refiners on the Pacific Coast have encountered peculiar conditions in the still tubes. After a tube failure had occurred in a furnace equipped with five-inch tubes with a wall thickness of 0.62 inches, one was removed for inspection. It was one of 16, each of which were 24 feet in length fabricated from cold rolled low carbon steel, which were placed in the roof of a still used for breaking the viscosity of a 10° A.P.I. topped fuel oil. The tube in question had been in service for about 10,000 hours when it failed.

A cross section of the tube showed that rapid thinning of the bottom had occurred, forming a trench like groove on the side nearest the most extreme furnace temperature. No apparent satisfactory reason has been advanced as to why the metal had been removed so rapidly from such a narrow portion of the wall. Some have advanced a theory that naphthenic acid may have been responsible, while others attribute the failure to a number of causes. One engineer who has had a similar experience partially explains the condition through the removal of metal by still tube cleaning equipment. Where coke had formed with a hard glaze, difficult to remove, the clean-out men run the turbines through the effected tubes a sufficient number of times to remove all of the coke layer from the upper side of the tubes. While doing this, the cutter head wears away the cleaned metal on the lower side of the tube, after all the coke has been removed.

A condition, far removed from cracking was found to be more or less prevalent in gas transmission pipe lines where moisture was present and saturated to a more or less degree with hydrogen sulfide. This pipe line was channelled in much the same manner as the cracking still tube, having a narrow trench cut about 1/16-inch deep. One refiner states that perhaps the severity of the tube corrosion was caused not so much by selective corrosion but the parts not affected were protected by selective coke deposition. A direct comparison between cold high pressure gas transmission pipe lines and high pressure, high temperature cracking tubes can hardly be made.

It may be, as one engineer expressed it, that the evolution of hydrogen sulfide is more rapid on the hotter side of the tubes, and consequently the reaction is greater at this point. Since naphthenic acid corrosion has been found to be most active at high temperatures, especially in the presence of water-free oil, a large amount of the localized corrosion occuring under such conditions and on the under side surface of the still tubes may be due to naphthenic acid and not to hydrogen sulfide, erosion, or decreased resistance of the metal caused by a metallurgical change resulting from overheating or distortion in fabrication as has been sometimes assumed.

Erosion, as well as corrosion has caused a large amount of deterioration of refinery equipment. Both corrosion and erosion usually accompany each other and assist in promoting a much greater rate of corrosion than that produced when the corroding agent acts alone. If erosion is absent, there forms on the corroded surface, or the surface exposed to the influence of corrosion, a scale which partially serves as a protective coating. If the scale is composed largely of iron sulfide, little protection is provided because it is loose and spongy and offers a fertile field in which corrosion rates are accelerated.

In zones not particularly afflicted by erosion, the question has been raised among the refiners generally as to whether or not coke acts as a protector. The experience of one refiner when running A.P.I. test specimens is that unless the coke is removed from the test specimens on each run, corrosion rates are abnormally low, whereas when runs are short, corrosion rates are abnormally high, indicating that corrosion is most rapid at earlier parts of a run prior to the building up of the coke. This refiner also concludes that by not removing all of the coke from the return bends corrosion rates are reduced. The reported spotted corrosion found inside some pieces of equipment is not due so much to selective corrosion as it is to selective protection by coke being left on the surface of the metals.

Another refiner originally thought that this layer of coke, which may average as much as 0.25-inch in thickness, would serve as a coating protecting from corrosion and particularly from erosion. In the oper-

ation of his cracking units, this coke is deposited at a fairly constant rate until it plugs up the equipment sufficiently to require shutting dome and clearing out. These operating cycles are from 100 to 2000 and 3000 hours long, depending upon the type of equipment and operation. He originally believed that the depreciation occurred mainly during the first hours of each of the operating cycles and then decreased very rapidly as the protective layer of coke had begun to be deposited over the surface of the steel.

Considerable data has been collected by him to show, however, that this rapid deterioration continues in spite of the presence of the layer of coke. In the zones of most severe turbulence, when one would assume that it would be impossible for the coke to adhere to the steel, the deposit will build up, constantly reducing the cross sectional area of the passage with resulting higher velocities and pressure drop and eventually plug the passage, if the equipment isn't already shut down due to the excessive high inlet pressure, which may increase to as much as 1000 pounds per square inch.

One refiner defines corrosion fatigue, or cyclic stress, as that action set up in a relatively long span of unsupported pipe line anchored at one end and encountering considerable vibration. Stresses are set up in the line near the anchor and intensified corrosion takes place at that point. He says that it is probable that cyclic fatigue is a result of cyclic stresses at the inter-crystalline zones or grain boundaries, causing intensified corrosion and failure at these points.

Another considers it to be a theoretical term resulting from considerable laboratory information published during the past five years by the A. S. T. M. He also says that this theory is often assigned to cover a failure difficult to explain.

Low temperature corrosion, or to be exact, that encountered while processing crude in simple distillation units while producing straight run gasoline causes very little difficulty. The principal points affected are the condensers, exchangers, water separators and reflux lines.

The chemists and investigators in one company have agreed that the low temperature corrosion as encountered in plants on the Pacific Coast may be explained by the electrochemical theory, and that the chemicals usually encountered in low temperature corrosion are hydrochloric acid and hydrogen sulfide. From information available it has been shown that corrosion from sulfur compounds in topping plants is comparatively negligible, with exception, perhaps, of those plants processing crude produced from the field at Venice. Greater concentrations of hydrogen sulfide have been found to exist in casinghead gas and oil from the productive sands in this field than any other area in California.

Salt water produced with the oil varies considerably, running from a very small quantity to as much as 75 percent. Naturally, with this condition facing the refiner, some of the magnesium chlorides and calcium chlorides will be retained in the oil after dehydration by the pipe line and transmission divisions, or companies. In the initial distillaton stage of the crude oil these chlorides are hydrolized, or broken down to form hydrochloric acid which is a very active acid when in the presence of water.

Soil corrosion of buried pipe lines within the refinery yards varies considerably as to the location of the plants. Where the terrain is more rolling and presents a good drainage surface, the external deterioration of plant pipe lines does not progress as rapidly as where the plant yard is flat with no natural drainage. The type of corrosion encountered is confined to pitting locally with a general scaling of the entire surface.

Corrosion from atmospheric influences as well as that caused from salt and fresh water used in cooling, is a problem not entirely solved. Some of the plants located near the ocean use sea water as a cooling medium, while others located points inland are restricted to fresh water for that purpose. Both have caused considerable difficulty through deterioration of headers, tubes, and transfer lines.

The interior of lead lines from pumps to cooling towers and cast iron headers on atmospheric sections have been corroded considerably. Pitting from the action of dissolved oxygen in the cooling water is responsible for a large portion of the loss of metal, while algae contributes largely by the formation of oxygen in the water. Not all the water available for cooling in the inland locations contains a large amount of minerals to form scale by evaporation. Because of the lack of a protective coating of scale, headers constructed of steel and cast iron rust rapidly.

Method of applying asphalt and cement protective coating to plant pipe lines.

Safety in Electrical Control

Interlocks in Hazardous Locations

X. D. IDES
Electrical Engineer

DURING the past few years, a great deal of activity has been manifested among electrical manufacturers in the design, construction, and of course, the distribution of equipment of the "explosion-proof" type. The idea has undoubtedly appealed to many a plant executive and engineer who have welcomed this innovation as something which would positively eliminate all their electrical fire hazard problems and troubles. It can not be denied, for instance, that the use of motors of the explosion-proof type has been a real boon to the industry, however, the idea has been extended to almost every piece of electrical equipment that may be installed in hazardous locations, and the hurry with which manufacturers have designed some of this equipment has left a number of very important points open for criticism. It is hoped, that the author's opinions and suggestions on this matter will correct the short comings and limitations of some of these devices, and will make for better, safer, and probably more economical installations in such locations.

A piece of electrical equipment is said to be explosion-proof, when it is so designed, as to mechanically withstand an explosion taking place within it, and which further prevents any flames or arcing in it from getting to the outside of the equipment and setting on fire ignitable gases. Before installing this type of equipment however, purchasers should not fail to answer for themselves the question as to whether these devices will actually eliminate fire hazards under all operating conditions. If this condition cannot be met, there is no justification for the considerably increased cost in their use as against the time-proven method of immersing arcing contacts in oil. This is true not only from the economical standpoint, but from safety considerations as well. For example, take the case of the explosion-proof contactor. This may be of the air type with its dreadnought boiler plate construction, or it may be of the equally heavy oil immersed type. Such devices, in the course of service gradually get out of order and require servicing of their pitted contacts. To work on them safely, it is necessary that a safety switch or other sectionalizing device ahead of them be first opened leaving the contactor terminals in the de-energized condition while the operator is working on them. This sectionalizing device may be at the contactor or remote from it, however, during this whole maintenance operation, there is not the slightest guarantee to the installation which contains ignitable gases and has presumably been safeguarded by the installation of explosion proof equipment, that,

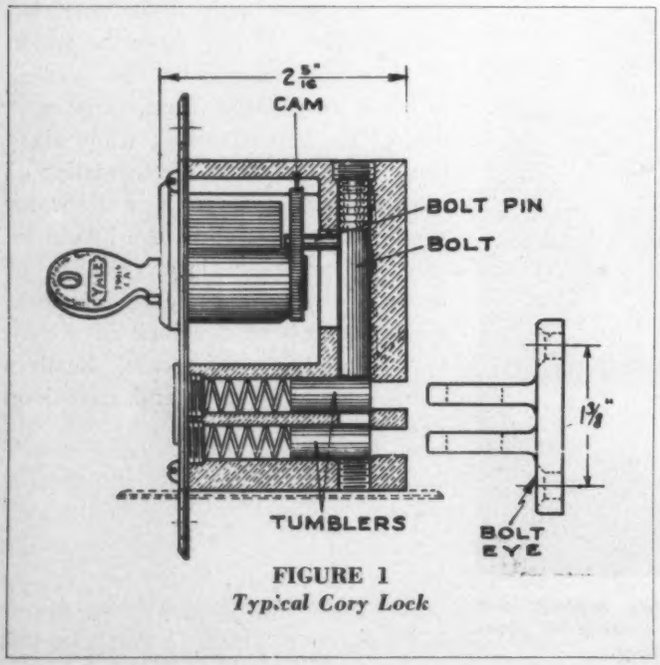


FIGURE 1
Typical Cory Lock

1. The tank or the cover of the contactor case will not be removed without first opening the sectionalizing device ahead of it, and
2. That while the contactor is thus exposed to the atmosphere, some one will not operate the push button and draw an arc, or
3. That the electrician or other operator while working on such a contactor may not accidentally close the contacts or otherwise touch live parts and accidentally draw an arc, or again,
4. That even though he has removed all potential from the particular device, some one, or for that matter, he himself has not forgotten and reclosed the sectionalizing device, thus re-establishing potential on one set of contacts while the device was exposed to the ignitable gases, or finally,
5. That he did not forget to replace the cover or the tank before leaving the installation.

The above points may sound somewhat far fetched,

but they are nevertheless possibilities and should not be overlooked. It is a well known fact, that familiarity breeds contempt, and all rules, regulations, and threats of dismissal will not change human nature on such matters. Let us not forget, that it takes just one little spark to start a fire, and to rely on the faithfulness and judgment of the operators alone to safeguard any given installation is therefore somewhat short sighted.

There are in the market today control devices both of the air and of the oil immersed type which have attempted to somewhat overcome the foregoing objection by the use of mechanical interlocks, whereby the cover of the explosion-proof device or of the tank of the oil immersed contactor, can not be removed unless the safety switch which is incorporated in the device is also in the off position. However, even such arrangements do not fully remove the objections previously mentioned, since the constricted space in these motor starters necessitates a rather compact arrangement of the base current carrying parts, with the consequent possibility of accidentally coming in contact with them even though the switch is in the open position. In other cases, the interlocks, although designed to prevent the removal of the covers when the switch is in the on position, nevertheless have not been so designed as to prevent the closing of the current carrying parts after such removal of covers or lowering of oil tanks. Obviously

FIGURE 3

Arrangement of 36 circuit oil immersed lighting distribution panel in a hazardous location. Note interlocking used.

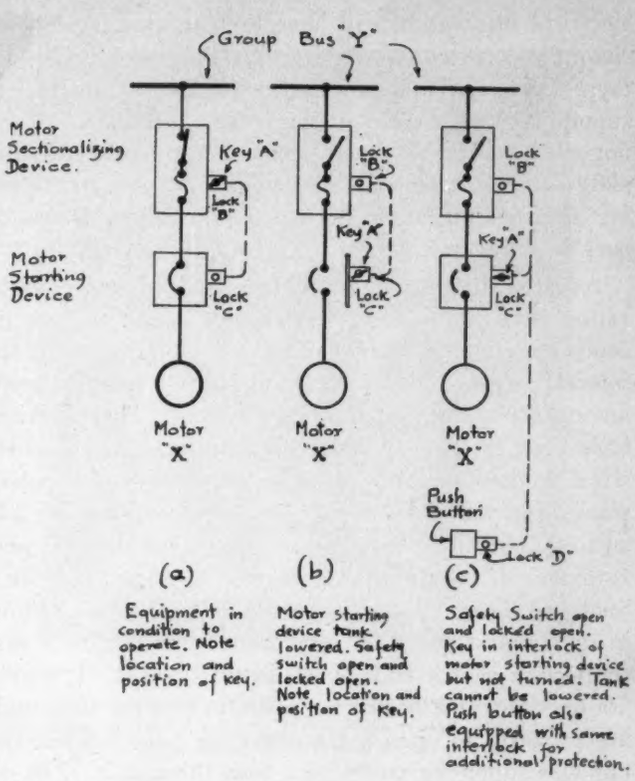

Group Bus "Y"
Motor Sectionalising Device.
Motor Starting Device
Key "A"
Lock "B"
Lock "C"
Key "A"
Lock "B"
Lock "B"
Key "A"
Lock "C"
Motor "X"
Motor "X"
Motor "X"
Push Button
Lock "D"
(a)
(b)
(c)
Equipment in condition to operate. Note location and position of key.
Motor starting device tank lowered. Safety switch open and locked open. Note location and position of key.
Safety Switch open and locked open. Key in interlock of motor starting device but not turned. Tank cannot be lowered. Push button also equipped with same interlock for additional protection.

FIGURE 2

with such arrangements, accidents may happen even with the best of precautions.

In view of the above considerations, and since the cost of control equipment for use in hazardous locations has mounted to the point where in many cases it even materially exceeds the cost of the explosion-proof motor itself, the question naturally arises: if a premium should be paid for such installations, should one not also demand that at least the objectionable points previously described also should be eliminated?

Hence, if costly explosion-proof equipment, and for that matter any control equipment, is to be used in any location requiring special precautions, it must meet all of the following requirements:

1. Operation of the control equipment must be possible only when the arcing parts are enclosed in an explosion-proof container, or are immersed in oil.
2. It should be impossible to open the explosion resisting container, or to lower the oil tank, unless potential has been removed from every terminal and every wire in this particular piece of equipment.
3. It should be impossible to re-establish potential on this device, unless the cover or the oil tank have been replaced in their normal position again.

Unless all of the above rigid requirements can be fulfilled, either by the engineer in charge of the installation, or by the manufacturer supplying the equipment, the cause for trouble will be always lurking around, ready to take its toll at any moment, and all the additional expenditures incurred to presumably obtain a safe

electrical installation will have been in vain. A chain is as strong as its weakest link, and if there are weak links in the methods used to supply electric service in hazardous locations, not much has been gained by the introduction of boiler plate equipment without also at the same time preventing this equipment from functioning when shorn of part of its armor.

As a solution to the problem, and in order to be rational on this matter, it is suggested that the use on control equipment located in hazardous locations of the interlocking system of locks and keys, better known among utility men as the Cory system. These devices have been extensively and successfully used in the electrical sections of large private and public utility power plants for the purpose of preventing damage to life and equipment by mechanically necessitating the performance of the proper sequence of operations before a final and desired operation could be performed. Thus, in its simplest form, let us consider the case of a disconnecting switch and its oil circuit breaker. It would not be safe to the life of the operator and the surrounding property to open a disconnecting switch while the bus was supplying power to a load through it. The oil circuit breaker has been introduced to safely accomplish this interruption. Hence, if the oil circuit breaker contacts were to be inspected, the proper procedure would be to first trip the oil circuit breaker, next open the disconnecting switches, and finally work safely on the breaker contacts. In large power plants where the controls, disconnecting switches, and oil circuit breakers are not located together, there is danger of the operator attempting to open by mistake the disconnecting switches of a feeder which it was not intended to take out of service. By the use of the Cory system of interlocks the possibility of such mistakes is eliminated as the operator in order to perform an operation on any piece of equipment has to first unlock it by the insertion of a suitable key in its lock. Since each circuit or operation has a distinctive key of its own, mistakes such as have been described above are eliminated. In the particular case under consideration, therefore, the oil circuit breaker is first tripped from the switchboard, thus releasing a key from a special lock linked with the oil circuit breaker mechanism. This key is removed from this lock and next inserted in the lock of the disconnecting switch gang operating mechanism. This permits the disconnecting switches to be operated, and after they have been opened permits the release of another key which when inserted in the lock at the oil circuit breaker compartment permits the opening of the doors and there-

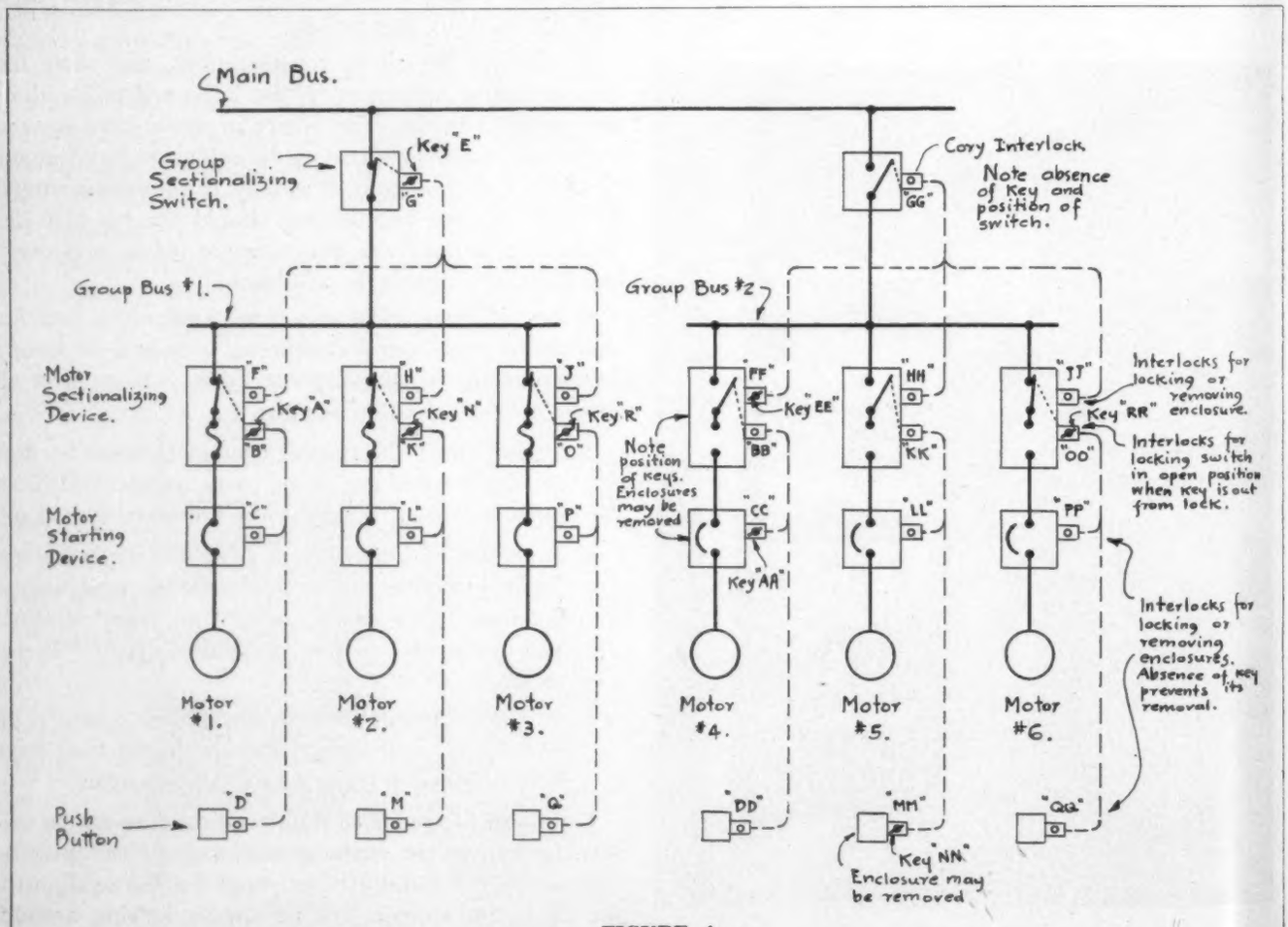


FIGURE 4

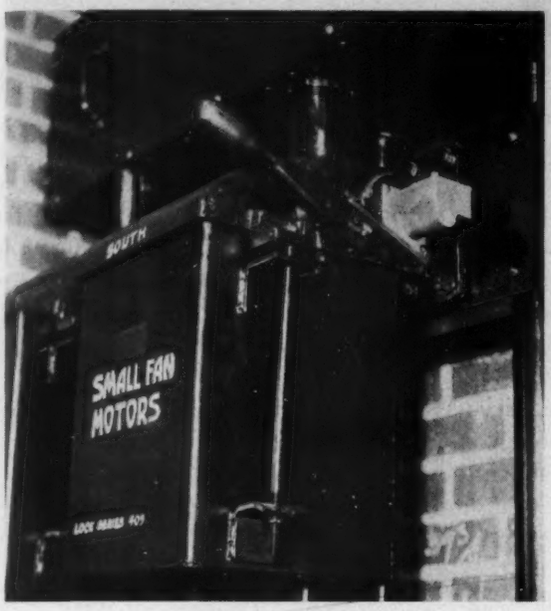


FIGURE 5A

Oil immersed safety switch in closed position, showing method used in mounting interlock.

FIGURE 5B

Oil immersed safety switch in open position. Note absence of key from lock which has been removed to open switch shown in Figure 6.

fore access to the oil circuit breaker tanks. The design of the locks is such that the disconnecting switches remain locked in the open position when the second key is removed to open the breaker compartment doors. The removal of the key from the breaker mechanism lock also interrupts the electrical control circuit for closing the breaker, in this manner the interlocking system insuring to the operator perfect safety from coming in contact with live parts or having his fingers injured by the operation of the breaker from the switchboard.

The Cory system of interlocks has been developed to protect in a large variety of complicated systems, each system utilizing procedures and equipment to fit its own particular requirements, the case just described being one of the simpler and more common in the power field. However, in industrial work, different conditions have to be met, and these being of a much simpler nature, will be reflected in correspondingly simpler interlocking systems. The safety which this interlocking system will introduce when used on control equipment installed in hazardous locations, should greatly enhance the value of well designed oil immersed controls at such points. The additional cost introduced by the use of this interlocking system is rather small, and as a matter of fact will be more than offset by the elimination of the armored type of equipment usually known as explosion-proof. Irrespective of this consideration, however, the installation will now become bona fide fire preventive, in that it will completely eliminate the dangers of the human equation, carelessness on the part of the operators. But far more important than the loss of material things, the value of these interlocks in safeguarding life and limb should not be lost sight of.

In order to better visualize the possibilities of these devices in the industrial field not only on electrical, but on mechanical applications as well, a knowledge should be gained of the simple mechanism used. By referring to Figure 1, it will be noted, that in its simplest form, the device consists of a lock body and a bolt eye or hasp. One of these parts, the lock body, is fastened to the stationary surface, and the other to the removable part of the device it is desired to lock. It will be noted, that the lock body consists of a lock, equipped at one end with a cam or arm which can be turned only by the key. This cam, in turn carries a bolt pin engaging a bolt, which therefore can move in and out of its seat by the turning of the key. It is obvious that if this bolt is restrained from moving, it will in turn prevent the key from being turned in the lock. If this position of the bolt is arranged by the design of the cam to also correspond to the "turned" position of the key in the lock, a means has been provided for locking the key in the lock. Since this key is the means of performing a second operation, it follows that a method has been provided for preventing the performance of this operation. This locking of the key, is brought about by the blocking of the bolt by two spring actuated tumblers. In order to remove this blocking, use is made of the bolt eye or hasp, which on being inserted into the lock body pushes these tumblers away from the bolt. When the bolt eye has been inserted as far as it will go, the holes in its prongs come directly in the path of the bolt, thus permitting it to move freely, and when in its extreme extended position, to enable the removal of the key from the lock. However, when in this position, the bolt securely engages the bolt eye or hasp, so that, if this

latter unit is in turn fastened to, let us say a tank or a switch handle, it locks this removable or movable part to the lock body, thus preventing its removal or actuation until such time as the turning of the key disengages the bolt from the bolt eye or hasp.

Bearing in mind the above operation of the mechanism, it can now be seen how nicely it fits the sequence required for properly operating electrical equipment. As a simple example, let us take the case of the circuit shown in Figure 2, which is typical of most motor controls. It consists of a sectionalizing and protective device and a motor starting unit, both of the oil immersed type. The safety conditions which this circuit and equipment must satisfy can be condensed into the following two requirements:

1. In order to work safely on the motor starting unit, it is essential, that the circuit sectionalizing device be opened and remain open while work is being performed on the motor starting unit, or while its tank is in the lowered position.
2. And conversely, in order to close the sectionalizing device it is essential that the motor starting unit tank be in the normal or operating position.

The above condition is fully satisfied by the installation of a lock body and bolt eye combination on each one of the two units making up the control arrangement of the circuit. When key A is in lock B, it permits the free opening and closing of the sectionalizing device. Since there is only one key for the two locks, the tank of the motor starting unit can not be lowered as the bolt eye attached to it is securely fastened to the lock body on the stationary part of the unit. To lower the tank, it is necessary that key A be inserted in lock C and operated so as to disengage the two parts. However, key A can be removed from lock B only if it is in the open position, that is, when the bolt eye which is fastened to the handle of the sectionalizing device has pushed the tumblers of lock B and permitted its bolt to move freely, a condition which also automatically locks this device in the open position. When key A has been inserted and turned in lock C, and the tank of the motor starting unit has been lowered, it can not be removed from lock C, thus permitting the operator to work in absolute safety on this device as all potential has been removed from it by the opening of the sectionalizing device, which is not only open, but also locked in this open position. In order to put the circuit back into service again, it is of course necessary to close the sectionalizing device. This can be accomplished only by the insertion and turning of key A in lock B. Key A, however, will obstinately refuse to be removed from lock C until after the tank has been lifted to its proper position, thus preventing the application of potential on the motor starting device parts unless they are immersed in oil.

An actual case of such a simple and inexpensive interlocking system is shown in Figure 3. This particular equipment represents a group of oil immersed lighting panels and their individual sectionalizing devices installed in a hazardous location. Each panel controls 12 circuits, and contains externally operated snap switches, cut-outs, and fuses, all of this equipment being immersed in oil. Since the occasional blowing of fuses requires their immediate replacement, and the internal arrangement of the panel is such as to expose considerable areas of energized equipment to the operator, it was considered desirable, both from the standpoint of fire prevention as well as safety to the operator, that some sort of an interlocking system be installed on these units. As a matter of fact, during the construction and prior to the installation of the interlocks, one of the electricians while testing the circuits, was careless enough to attempt inserting and removing fuses from their cut-outs with his uninsulated metal pliers, instead of using the specially provided devices for this purpose. He had performed this operation quite a number of

FIGURE 6

Special explosion-proof manual small motor starters. Key has been removed from lock in Figure 5B and inserted in lock mounted on cover of switch to the right, permitting removal of oil tank and cover.

times without any mishap, and had exidently become quite sure of himself. But he missed his aim once, and the psychological shock which he received caused him to fall from the scaffolding on which he was then standing. Although the height from which he fell did not exceed four feet, he fell in such a manner as to injure his back and be confined in bed for several weeks. The interlocking system which was shortly after installed, makes it impossible to open and work in the panel unless all potential has first been removed from it by the opening and locking in this position of the sectionalizing switch ahead of it, and conversely, the sectionalizing switch can not be closed, unless the cover of the distribution panel is locked in the closed position.

In introducing Cory interlocking systems on any given

industrial installation, a certain amount of consistency should be shown throughout, as in the absence of such an arrangement, the partial installation of the protective equipment is apt to defeat the purpose for which it was provided. To illustrate, let us refer again to the case of the circuit shown in Figure 2a. If for instance the motor starting device was of the contactor type with a push button which was not an integral part of the unit,

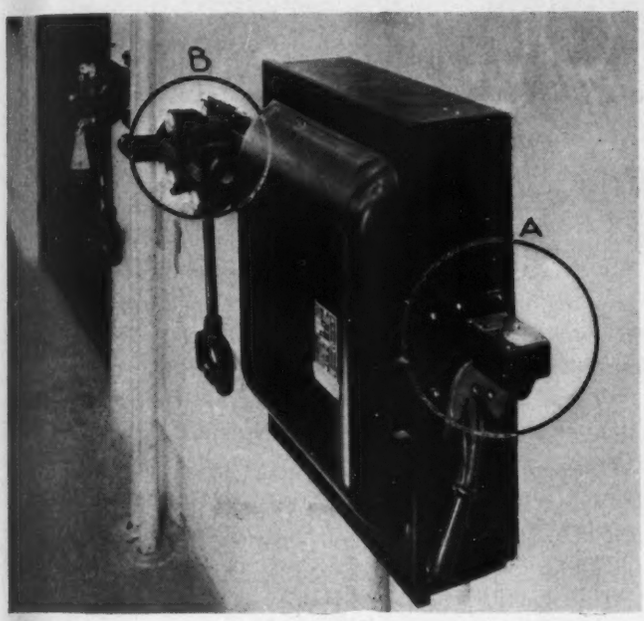


FIGURE 7
Typical mounting of interlock on air type safety switch.

then, it is quite evident, that full protection would not be obtained unless this push button also was equipped with the same interlocking mechanism used on the motor starter. In the absence of such a provision, there would be no guarantee, that the push button would not be opened before potential was removed from it by the opening and the locking in this position of the circuit sectionalizing switch. This has been provided for in the arrangement shown in Figure 2c. The idea could be further extended so as to prevent the lowering of the tank of the sectionalizing device itself, unless also all potential was removed from this unit too. Such an arrangement is illustrated in the circuit of Figure 4. The interlocking system used for this purpose does not differ in any way from the ones previously described, except that an additional interlocking mechanism has been installed on the sectionalizing switches for each individual motor circuit. A common key, in this particular case designated as key "E," permits the interlocking operations to be performed between the group sectionalizing switch and the individual circuit sectionalizing switches. Needless to say, when this system is installed and it is desired to work on any of these latter switches, it will necessitate the stopping of the entire group of motors supplied through this group sectionalizing switch.

An arrangement somewhat similar to the above was recently installed in an area containing inflammable gases and liquids. The interlocking used is shown in Figures 5 and 6. Two main oil immersed fused safety switches shown in Figures 5a and 5b supply power to two groups of ventilating and heating fans located in a building a short distance from the sectionalizing switches. There are six small motors in one group, and seven in the other. The starters for the individual motors are located in the building near the motors themselves. They are of the manually operated type, but of special design providing operation of the contacts in oil, and thermal and short circuit protection to the motor and the circuit as well. The device consists of an externally operated three-pole oil immersed snap switch, and in a compartment directly above it of a three-pole, 30-ampere cut-out equipped with special thermal type fuses. Access to this compartment is obtained by unscrewing the cover at the top of the unit, and the snap switch can be reached by unscrewing the oil tank from the stationary part of the device. Boiler plate construction has been used throughout, with joints conforming to Underwriters requirements for extra hazardous locations. These units, with their specially developed interlock mechanisms are shown in Figure 6. It is interesting to note the interlocking system method used. The lock body is fastened to the cover, while a chain connected at its free end to a specially designed hasp is attached to the oil tank. Since both cover and tank have to be turned several times before they can be removed from their seats, an excellent locking of these two parts to the stationary part of the unit is obtained. To inspect any switch in a group, it is first necessary to obtain the common key from the main sectionalizing safety switch located at the control house. This, of course, can be accomplished only by opening and locking in this open position of the sectionalizing switch. The various units in this group can then be opened one at a time and inspected. To place the system back into service again, the key is removed from the last unit by first screwing into position the top and the tank of this unit and then locking them together by means of the chain carrying the hasp.

Any misconception which the above discussion may have conveyed relative to the foolhardiness of these interlocking devices should be clarified and removed. They are far from being fool-proof if one wishes to tamper with them. A pair of screw drivers will just as easily permit the release of a locked key as the bolt eye itself. But we are not dealing with mischief makers of this type, but rather with operators who mean well, but who as a result of their self assurance, or of their carelessness fail to observe the proper precautions. To such men the system provides a jolt by refusing to respond to their wishes, and by thus waking them to the realization that they are proceeding in the wrong direction and that they should retract their steps and follow the proper routine. There is no hard and fast rule as to what constitutes the proper amount of precaution in such cases.

Low Voltage Refinery Controllers

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FOR most practical purposes, refinery motor controllers may be considered linestarters for squirrel cage motors. Reduced voltage starting controllers for this type of motor are made up of similar elements, differing only in detail, and synchronous motor controllers, whether for full voltage or reduced voltage starting usually are quite similar to squirrel cage motor controllers, with added auxiliary equipment for connecting the motor field to the exciter circuit. Therefore, a discussion of squirrel cage motor linestarters may well cover almost the entire field of control equipment of special interest to refinery engineers.

The elements of a linestarter circuit are a disconnect switch, a circuit interrupting device to protect all parts of the circuit against short circuit, a magnetic contactor, a relay to protect the motor from sustained overloads and a start-stop pushbutton. These parts may be mounted in one or more enclosures for the protection of the starting equipment itself or adjacent equipment.

In point of numbers now in service, the manually operated, fused knife switch far outranks any other device used as a circuit disconnecting and short-circuit protective device. Until recently, this was the only practical equipment available. Since the introduction of the type de-ion circuit breaker, a device is available which may be used to disconnect a circuit from the line under load, and with which the circuit may be reconnected without the delay and expense of fuse replacement.

The breaker consists essentially of a manually operated, quick-make, quick-break breaker and an overload tripping device. Although the breaker is manually closed, it cannot be held closed against a short circuit or other overload in excess of the value for which the tripping device is set. The tripping device is a thermal element or, in certain ratings, a magnetic device. The thermal tripping unit has inverse time delay characteristics up to approximately 10 times its normal setting, at which point it trips instantly. The magnetic element provides instantaneous tripping at a fixed current, and is normally set for eight to 10 times the full load current of its motor.

With either type of tripping element, the breaker may be closed when the trouble in the circuit has been cleared without the expenditure of a new fuse or the delay in waiting for a new fuse to be brought from the storeroom, and since the tripping element is normally sealed against tampering, the value of the tripping current may not be changed except by substituting a different rating.

These breakers are able to interrupt currents of great magnitude because of their extremely rapid action in opening and because of the de-ion arc quenchers with which they are equipped. Normally the circuit will be opened in ½ cycle or 1/120 of a second, limiting the burning of contacts to a negligible amount even under severe conditions.

The duty of the contactor is to close the circuit to the motor and to open the circuit under normal conditions, or when an excessive overload exists up to any load which will stall the motor. Progressive improvements, brought about through years of association with all industries, have brought contactor design to a high state of perfection. The recent introduction of the de-ion arc quencher principle, used in contactors as in breakers, greatly lengthened the life of contacts by reduction in burning, and improved reliability by providing more positive arc interruption.

The thermal overload relay, used as a part of the linestarter, permits the motor to start heavy loads, but will trip the contactor on sustained overloads before the motor temperature reaches a damaging point.

The item in controller design which probably has received, deservedly, the most attention recently is the enclosure. In general, refinery conditions require one of these three types of enclosures.

1. Enclosures which are explosion resisting and relatively imperious to corrosive vapors inside and outside.
2. Enclosures which are explosion resisting, of corrosion resisting material, and which protect the electrical parts by immersing them in oil.
3. Enclosures which are weather-proof and corrosion proof.

Figure 1 illustrates a simple linestarter in a cast iron case, with a wide accurately machined metal-to-metal fit between the case and its cover to cool the gases of an

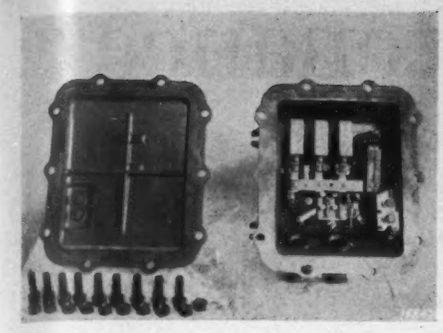

FIGURE 1
Explosion resisting weather-proof line starter.

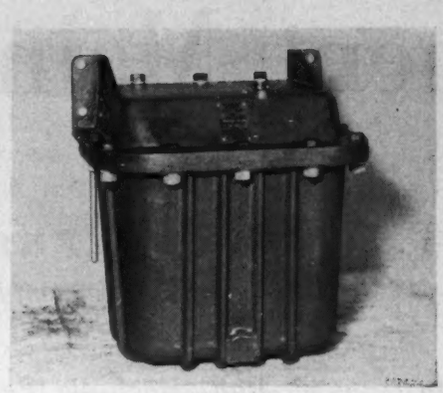

FIGURE 2

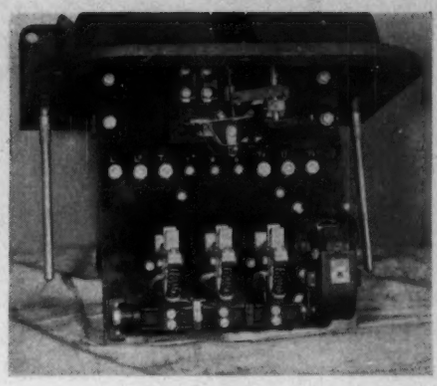

FIGURE 3

Oil immersed weather-proof line starters for use in Class 1 Group D locations.

internal explosion to a safe temperature before they reach the atmosphere, thus providing an explosion seal. Such equipment is suitable for use indoors or outdoors in hazardous atmospheres where corrosive elements in the air are of minor importance. This starter includes a thermal type overload relay and a built-in start-stop pushbutton.

Where both explosive and corrosive vapors may be present in concentration, an oil immersed starter enclosed by a cast iron tank and cover will provide adequate protection against both these elements. A starter of this type is shown by Figures 2 and 3. The cast case, which is strong enough to withstand an internal explosion, is highly resistant to both acid and alkali, and is weather-proof. The oil covering the electrical parts protects them from corrosion.

Frequently, it is possible to avoid explosion hazards by placing electrical equipment outdoors. Exposure to the weather in refinery areas usually increases the activity of corrosive elements, making it necessary to provide a controller case of corrosion resisting materials which is practically air-tight.

A simple linestarter of this type with built-in pushbutton is shown by Figure 4. The housing is of cast iron. A large soft-rubber gasket, tightly compressed between the cover and case, minimizes "breathing" by which corrosive vapors would otherwise enter the enclosure. A similar construction is illustrated by Figure 5. Built into this housing are a contactor type of hand-operated, fused disconnect switch and a linestarter.

A recent development of the unit construction idea is shown by Figure 6. This controller consists of a de-ion breaker and a linestarter, both mounted in a single cast iron case, sealed for weather and corrosion protection by a heavy soft-rubber gasket. The breaker is operated by an external lever mounted in the cover.

Since all of these controllers were built to comply with refinery requirements, they indicate trends, not only in electrical equipment, but also in refinery construction. First, there is the increasing use of electric drive with equipment of a type which will avoid the introduction of any new hazards as compared to steam drive. This is accomplished by the use of explosion resisting equipment in buildings or other places where the possibility of gas concentration cannot be eliminated.

Second, there is an increasing amount of construction in which pumps and their associated electrical equipment are placed out of doors. This type of construction is cheaper in first cost and in maintenance, when building maintenance is included, and frequently results in the entire elimination of explosion hazards.

Third, refiners find it advantageous to use unit type apparatus, with disconnect-breaker and starter in a single enclosure. This reduces installation expense and simplifies the work of inspection and maintenance.

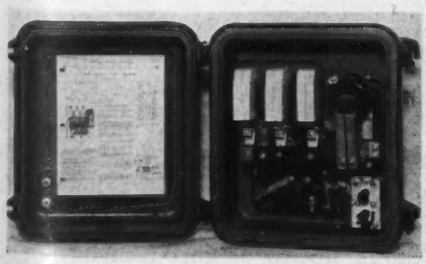

FIGURE 4
Weather-proof line starter and built-in push button.

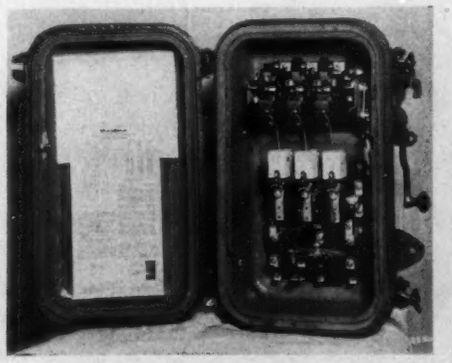

FIGURE 5
Combination fused manual disconnect and line starter in weather-proof housing.

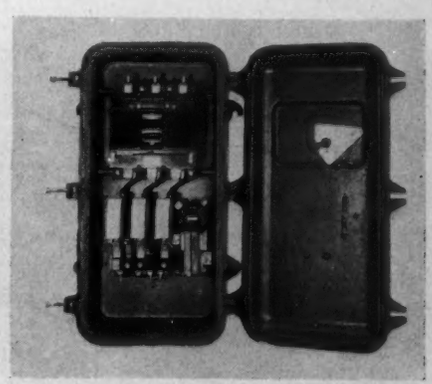

FIGURE 6
Combination breaker and line starter in a weather-proof case.

Instrument Maintenance

[Part 2]

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BALANCING the moving coil and pointer of a galvanometer of either an indicating or recording instrument is not a difficult operation, yet some repair men seem to make it so. In Figure 14 an indicating instrument case is shown but the same positions are applicable to a recorder movement. It also applies with slight modifications to those models with two counter-weights at right angles to the pointer.

The movement can be balanced closely out of a case but due to its delicacy should be finally balanced within a case to prevent air current from disturbing the true position.

In the figure the arrows show the direction in which it is desired the pointer be moved.

First turn the movement to the position shown in 1 row I. If the pointer does not return completely to zero, bend the counterpoise to the right. When in position 2 and desired to move the pointer as shown, move the weight in.

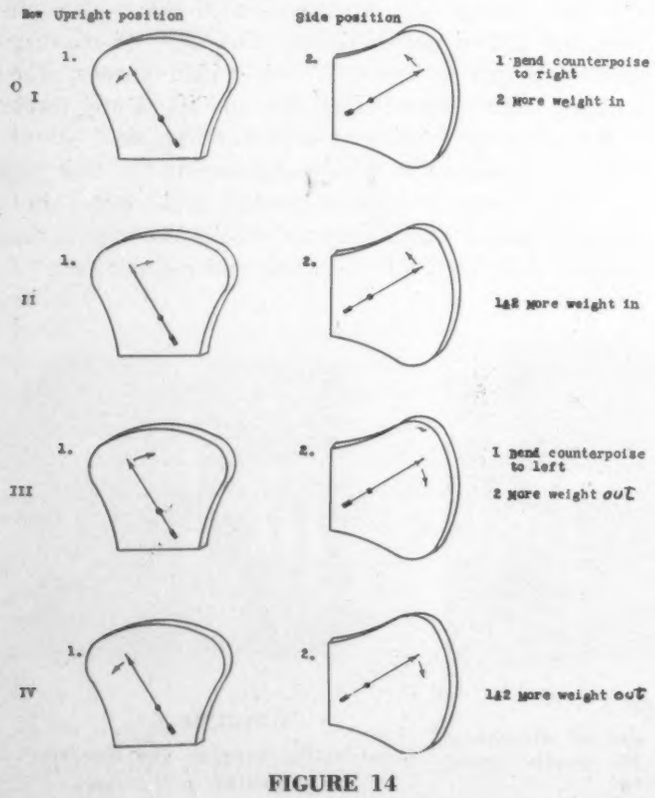


FIGURE 14

In row II both corrections are made by moving the weight in.

In row III position 1 is corrected by bending the counterpoise to the left and position 2 by moving the weight out.

In row IV the corrections for both positions are made by moving the weight out.

The instrument should normally be set and balanced at 75°F. unless a different cold junction value is to be used.

When a pyrometer shows a sluggish movement or movement after tapping the instrument, the cause may be one of the following:

1. Metal filings in the air gap.
2. Dust between coil and core.
3. Pivots too loose or too tight.
4. Pivots blunt or jewels broken.

The induction coils used in the manometers, indicators, and recorders of those instruments transmitting by means of the inductive bridge principle are identical in the newer instruments and in pairs have a balancing effect. But in some of the older instruments when replacing single coils sometimes the pair is found out of balance. These are balanced by shortening or lengthening the coil and by placing soft iron plates at each end.

Turns taken out of the top part of the lower section of the coil have the same effect as adding an iron plate to the top side of the coil. Turns taken out of the lower part of the upper section of the coil have the same effect as adding a plate to the lower end. When getting a mechanical balance the movement of from 0° to 90° is decreased by taking out turns.

To get a balance, turns should be taken from the coil according to Figure 16. The dotted line indicates how far the movement is out of balance.

It is very inconvenient to remove a flow meter and take it to the shop whenever a water column check is desired. And it is nearly as inconvenient to rig up a water column at the manometer. Figure 15 shows a handy "dry" portable water column for checking flow meters on the job. To facilitate zeroing the column the scale is adjustable up and down.

Where air pressure is obtainable the connections are as shown. The proper height of the water column is controlled by finger pressure and can be locked at any position by the needle valve just below the finger controlled opening. In case no compressed air is available, a hand aspirator or bicycle pump can be attached at the finger pressure opening to obtain the pressure for regulating the height of the water column. With this "dry" column, piping is simplified, while careful leveling necessary when a water column only is used is eliminated. Also the difficulty of entrained air in the manometer when water is used no longer exists.

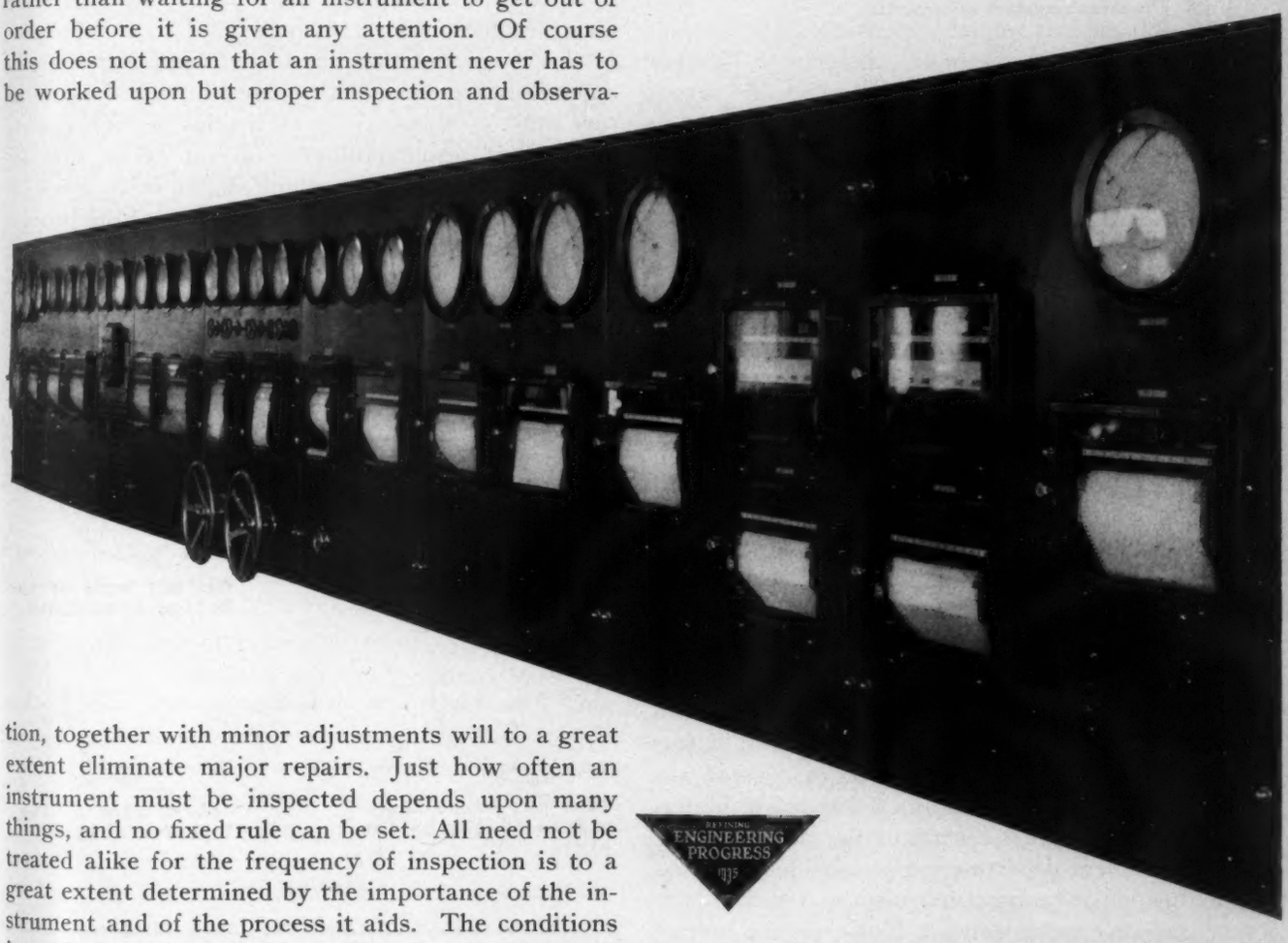
The correct maintenance of instruments is in forestalling repairs by proper methods of inspection rather than waiting for an instrument to get out of order before it is given any attention. Of course this does not mean that an instrument never has to be worked upon but proper inspection and observation, together with minor adjustments will to a great extent eliminate major repairs. Just how often an instrument must be inspected depends upon many things, and no fixed rule can be set. All need not be treated alike for the frequency of inspection is to a great extent determined by the importance of the instrument and of the process it aids. The conditions in each plant then would regulate the attention each instrument should receive.

A complete and detailed method of recording facts regarding all instruments as well as tests, inspections and repairs is invaluable in maintenance. Just what form it must be in will depend to a great deal upon the size of the plant. In other words, the greater the number and variety of instruments the more in detail it will be necessary to record the various changes made.

Simple forms are shown in Figures 17 and 18. These record the fundamental data regarding the instrument together with the date of purchase, where located and the major repairs done upon it. Some companies go into further detail in regard to repair parts and costs but how far one should go is a matter of opinion and it should be remembered that too much detail defeats the purpose of useful information.

In order to keep close check on the movement of instruments in larger instrument departments it is well to tag all instruments brought to the shop for any purpose with a card showing the serial number and other data. A form for this is shown in Figure 19. When the instrument is put back in service the ticket is removed and the record transcribed on the individual meter record.

The number and variety of charts necessary in the growth of a refinery, together with the obsolescence of certain instruments, requires some sort of record be made of those active as well as the daily or monthly requirements. Figures 20 and 21.



The periodical checks made upon the various pyrometers should be made out in duplicate with the original filed for future reference and the duplicate sent to the foreman of the process or posted for the operators to observe the extent of the errors found. Figure 22.

In addition to these forms there should be a log book or trouble report in which is recorded the operators' complaints or requests for checks, who an-

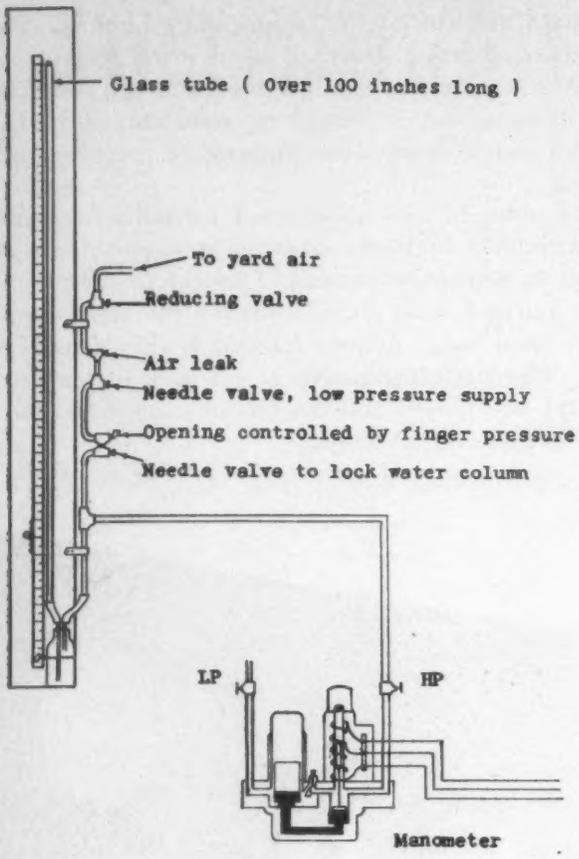


FIGURE 15

swered the call, and what was done, time and date received and when completed.

True maintenance work means that the repair men must, where possible, redesign controls or apparatus which, while fulfilling the manufacturers' guarantees, do not perform for the best results in the process. An example of this is the case of a company which purchased some electric flow meters for recording and controlling the flow of oil to the cracking and reducing furnaces of some large cracking units. Originally the meters actuated motor operated valves in the steam lines ahead of the throttle valves of turbines driving the pumps. This type of control was unsatisfactory and the operators discarded it, preferring to use the manual control of the turbines.

The instrument department first considered changing the turbine governor mechanism to one similar to a synchronizing motor control. However, the turbine manufacturers insisted that while this could be done yet so many changes in design would be necessary that the cost would be rather high.

The instrument department then designed a compact unit of motor and reducing gear to operate directly on the hand control of the existing governor. The cost of the entire unit and installation was about $50. The result was surprising and gratifying in the excellence and closeness of control. In addition a slight steam saving was made due to controlling from the turbine governor instead of from the steam line.

As refining units become larger and more complicated it becomes necessary that they be operated and controlled as far as possible by devices that detect minute changes in conditions and act to correct those that are detrimental to the process. The larger operations are so complicated that it has become impractical to operate with manual control wherever automatic control can be obtained at reasonable cost. The result is an infinite number of mechanisms of various degrees of delicacy and complication. The tendency is towards machines of greater refinement and intricacy with equipment formerly thought of as of use only in the laboratories now common in the work of the process.

As the process becomes more and more dependent upon correct action of delicate equipment it is evident that the upkeep and the repair of these mechanisms becomes more and more vital to the process. It also is evident that due to the complexity of this apparatus the maintenance men intrusted with its care must of necessity be mechanics of high quality of skill and resourcefulness. In fact we are fast approaching the condition where skilled instrument repair men are as essential to the success of the process as good operators. And in reality the highest class of instrument man must have a working knowledge of the process in order to ascertain when the instruments are performing satisfactorily.

All of these requirements point to the fact that a high class instrument man is of most importance and

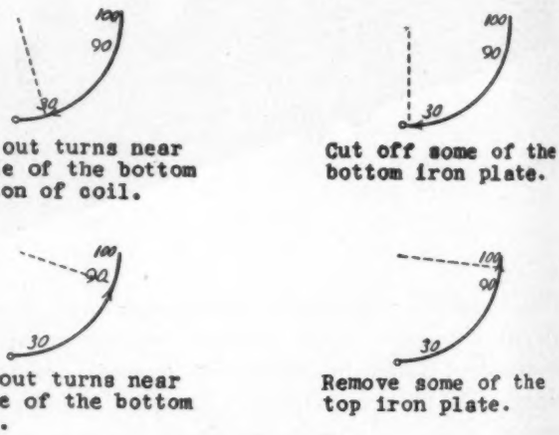


FIGURE 16

Model 2021—X42		Model	Manometer Model 2054-6
Serial #78128		Serial	Manometer Serial #76437
Depression Rate		Warren Clock RPM B-1	Date Purchased 2-30
SERVICE		REPAIRS	
Date	Location and Type		Work Done
9-12-32	#2 Power Plant—150# N Loop	8-24-32	Calibrated and integrator repaired
9-15-32	Spare for #78128—replaced	7- 1-32	New integrator parts and #2 tube
	with #74150	12- 7-33	Monom. froze—no damage
		2- 8-33	Monom froze—refaced & new coil
		5-30-33	#3 Range Tube installed

FIGURE 17

Model 2061—830—chart #951		Model 2021-42	Manometer Model 2054-5
Serial #109632		Serial #108705	Manometer Serial #108156
Depression Rate 7½ Sec.		Warren Clock RPM 2 Type C	Date Purchased 5-1-1931
SERVICE		REPAIRS	
Date	Location and Type	Work Done	
8-1-32	#5 Cross Still—Hot Oil Control	2- 8-33	Manom. frose—refaced—replaced
			with #72837 from #15 Cross
			Still Reflux
		5-31-33	#109632 Renewed vertical pointer
			cleaned and polished bearings.
			Renewed lower pointer bearing

FIGURE 18

Serial #
Repaired
Range
Ext. Res.
Removed
Date
Put in
Date
Notes

FIGURE 19

should be recognized as such in position and pay. An instrument department should be under the supervision of well trained technicians so that solutions to problems involving instruments can be efficiently reached in addition to maintaining expertly those instruments under its care.

The personnel should be varied and include those specially qualified as specialists in various groups of instruments such as controls, pyrometers, flowmeters, etc. It would be well to include with this group those men who are detailed to do test work in the various processes. This will facilitate the use, checking and calibration of those instruments used in special tests. The general run of maintenance and checking men need not be so highly skilled in mechanics as those who do the actual instrument repair work. These should be men with experience as watchmakers or tool makers as a basis of mechanical work, with some electrical knowledge and with some factory training.

Under the instrument department should be concentrated the responsibility of the supervision and upkeep of all measuring and control equipment. This should include the collection and inspection of all charts as well as whatever calculations are necessary in passing on their totals to the proper departments.

The instrument department should be centrally located or where it is conveniently accessible for the greatest number of instruments. This is important for quick service or in emergencies. It should include equipment for testing, checking and repairing pyrometers, flowmeters, thermometers and pressure gauges. The checking of pyrometers and couples requires potentiometers, millivoltmeters, resistance boxes, battery boxes, standard couples, an electric furnace, small electric and gas welding outfits and a multiplicity of small special instrument repair tools. Flow meters must be checked against water columns. Both fixed and portable ones are desirable. Thermometers are checked against standards with a variable controlled steam chest for medium temperatures. Pressure gauges require a dead weight test gauge. There should also be a small drill press, buffer and bench lathe to facilitate the work. It is also advisable to separate the repair work; such as putting pyrometer repair work in a special room.

STRIP CHART #951		
Instrument Co.	Range 0–100	40 day Chart
Used On	Used For	No. Charts
Cross Stills 1–10	Charge to Still	10
Cross Stills 17–20	Charge to Reducing Furnace	4
	Charge to Cracking Furnace	4
	Fresh Feed	4
Coke Stills Bat. #3	Feed to 21–25 Stills	1
	Feed to 26–30 Stills	1

FIGURE 20

CIRCULAR CHART #2215		
Instrument Co.	Range 0-200#	24 hour Chart
Used On	Used For	No. Charts
Cross Still 1–20	Main Steam Lines	10
Boiler House #8	Main Steam Lines	1
Refrg. Plant #2	Main Steam Lines	1

FIGURE 21

TEMPERATURES							
Cross Still #3			Time 9:30 A.M.			Date 7-26-34	
Position	Correct Temp.	Pyrometer	Error	C. J.	Correction Milivolt	Potentiometer	Correct Milivolt
TL	919	918	—1	94	+0.7	34.8	35.5
MSC	659	660	—1	94	+0.7	23.2	23.9
BT	386	385	—1	94	+0.7	11.7	12.4
MSC	850	851	+1	94	+0.7	31.75	32.45

FIGURE 22

Laboratory Evaluation of Oil Stocks

W. L. NELSON
*Consultant**

Evalaution of Lubricating Oils and Use of Replica Plants

PART III

THE evaluation of lubricating oils, cracking stocks, stocks for treating and stocks for newly developed processes are so difficult that special methods must be used. The construction of a replica of the plant equipment is the best way to handle these troublesome evaluations and the customary laboratory procedures are usually not dependable.

EVALUATION OF CRUDE OIL FOR LUBRICANTS

Except in the evaluation of paraffin base oils which contain no tar, special methods must be used in evaluating lubricating oils. The equipment and procedure that is used is essentially a duplication of the operations in a refinery that manufactures lubricating oils by vacuum distillation. Most of the coloring material (tar etc.) is removed by a vacuum distillation which leaves these materials in the residue tar. The removal of asphaltic and tarry materials from the lubricating oils is necessary because the chemical treatment of residual cylinder stocks in the laboratory is not a satisfactory operation.

In the plant the crude oil is first topped for gasoline, kerosene and some gas oil, at atmospheric pressure. In the laboratory this operation is conducted in a batch steam still. See Figure 1. The fractionation need not be good because all of the lubricating oil is left in the topped or reduced crude oil and the reduced crude will be carefully fractionated in a subsequent operation. In the plant the tar is eliminated in a vacuum distillation system. In the laboratory this operation is conducted in a vacuum flash vaporizer. This vaporizer must operate continuously so that flash vaporization occurs. The cylinder stock cannot be vaporized in a batch distillation such as the Hempel or true boiling point distillation, because too high a temperature is required. Refer to Figure 5 in Article I of this series†. In the plant the distillate by vacuum flash is immediately fractionated into products in a vacuum fractionating tower. In the laboratory the distillate by vacuum flash is condensed and subsequently analysed by a true boiling point evaluation.

*Professor of Petroleum Refining—University of Tulsa.
†Refiner, January, 1935; page 17.

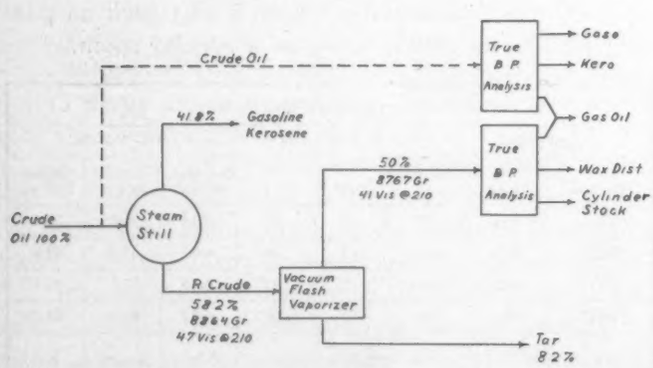


FIGURE 1
Laboratory processing for evaluating lubricating oil in crude oil.

The lubricating oil stock is referred to as a "heart-cut" lub stock because it contains all of the lubricating oil and because it is taken from the center of the crude oil. The gasoline etc., is removed from the front of the crude oil by steam distillation and the tar is removed from the high-boiling end of the crude by vacuum flash vaporization. These operations are clearly indicated in Figure 1. The dotted line in Figure 1 indicates a separate evaluation for gasoline and kerosene.

The curves for these two evaluations, the analysis of the "heart-cut" lub stock and of the crude oil, are shown in Figure 2. The two analyses were plotted on the basis of the crude oil so that the analysis of the lub stock starts at 41.8 percent on the crude oil and ends at 91.8 percent. The dependability of the true boiling point method of evaluation is indicated in Figure 2. The circle points were obtained in the analysis of the crude oil and the triangle points were obtained in the lub stock analysis. The distillation curve of the lub stock (curve 2—Figure 1) starts at a point much lower than the crude oil curve. This is due to the poor fractionatioon in the steam distillation. However, the two curves are coincident at about 700° F. and this is all that is important because all of the lubricating oils are contained in the material that boils above 700° F.

The "heart-cut" stock is particularly suitable for the evaluation of lubricating oils because the residue from a distillation of this stock is a clean, good-color cylinder stock. The distillation of the lub stock is continued until the residue is the highest viscosity cylinder stock that will be desired in the plant. A viscosity yield curve

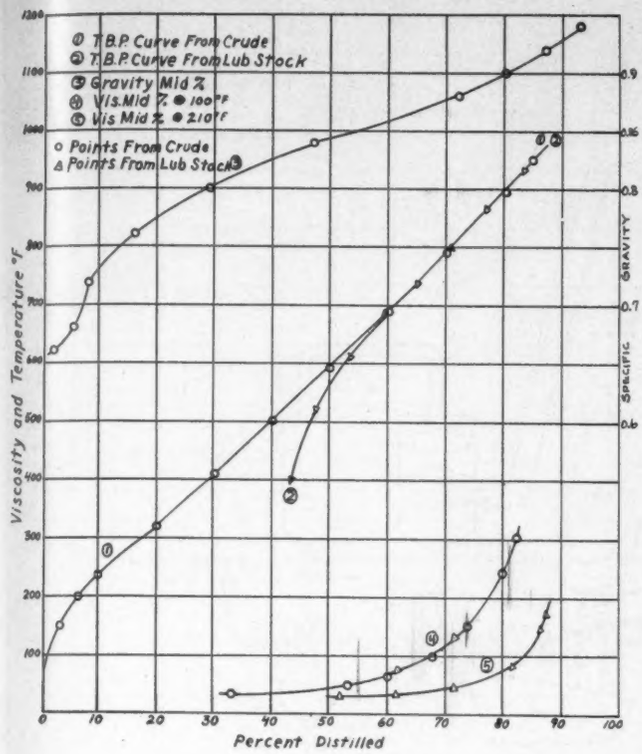

① T.B.P. Curve From Crude
② T.B.P. Curve From Lub Stock
③ Gravity Mid %
④ Vis. Mid % @ 100°F
⑤ Vis Mid % @ 210°F
o Points From Crude
Δ Points From Lub Stock
Viscosity and Temperature °F
Gravity
Specific
Percent Distilled

FIGURE 2

Curves for evaluating lubricating oils.

for the various cylinder stocks is then determined by blending the last fractions from the distillation with the residue fraction. The construction of this curve is explained in the second article of this series. Such a yield curve, based on the operation shown in Figure 1, is given in Figure 3. This figure is based on the "heart-cut" stock (50 percent of crude) and hence the yields of cylinder stock, based on the crude oil, are obtained by dividing by two. The curve (Figure 3) is of no significance unless the percentage of tar is 8.2 percent as obtained in the flash vaporization operation. In the laboratory, an effort is made to produce the same yield of tar that will be obtained in the plant. To produce less tar (or more) in the laboratory than can be obtained in the plant will give a dfiferent viscosity yield curve. In commercial operation the lowest practical vacuum that can be obtained is about 30 mm (at vaporizer). This pressure along with steam (vaporizer 680° F.) is about equivalent to a pressure of 7 mm. in the laboratory vaporizer and a temperature of 700° F.

TABLE I.

Lubricating Oil Evaluation

Material (Raw Stocks)*	Percent	Specific Gravity	Viscosity	Notes
400 E.P. Gasoline	32.	.748	.....	420 cut-point
41-43 Kerosene	6.4	.813	.....	Curve 3—Fig. 2
Gas Oil	22.3	.843	.....	By difference
100 Neutral	12.7	.87	100 @ 100	Curve 4—Fig. 2
200 Neutral	8.2	.892	200 @ 100	Curve 4—Fig 2
150 Bright Stock	10.2	.915	150 @ 210	Figure 3
Tar	8.2	...	.....	Figure 1

*The finished yields are somewhat smaller because of treating and dewaxing but the loss is small because these stocks contain no tar.

An example break-up of the crude oil shown in Figures 2 and 3, will clarify the manner of using these curves. The computations are much the same as the ones given in Article II of these papers.

VACUUM FLASH VAPORIZER

The laboratory vaporization of lubricating oils leaving a residue of tar, is a difficult operation. It necessitates a special design of vaporizer in order to operate at a vacuum and to operate continuously for several hours without a change in the operating conditions. The vaporizer must operate at about 7 mm pressure at 700° F. in order to vaporize cylinder stocks. This is equivalent to 1000-1050° F. when converted to atmospheric pressure and since the vaporization occurs by flash, material boiling to about 1200° F. at atmospheric pressure, is vaporized.

Many types of vacuum flash vaporizers have been built. The vaporizer shown in Figure 4 is a successful one but it is not necessarily the best vacuum flash vaporizer for all purposes. The equivalent is essentially a replica of a modern vacuum distillation plant except that no attempt is made to fractionate the vapor into finished products. The aim is to vaporize as large a percentage of oil as possible even though the fractionation is imperfect and hence no more reflux is used than the small amount that is required to prevent entrainment of tar into the distillate. The pipe still of a commercial unit is replaced by a coiled steel heating tube cast in aluminum. Insulated resistance heaters are also imbedded in the casting and they are connected with an automatic temperature control. The aluminum casting acts as an excellent reservoir for heat so that large temperature fluctuations are impossible; it facilitates the transfer of heat from the resistances to the oil and its temperature can be easily controlled by an automatic

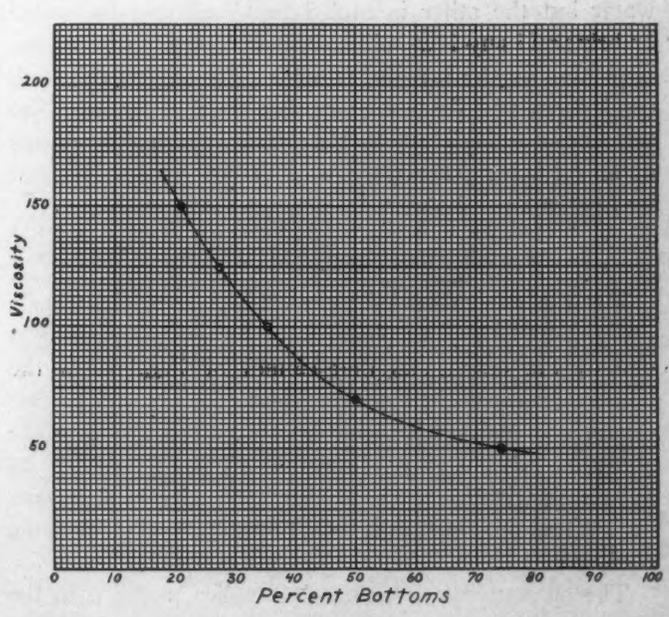


FIGURE 3

Viscosity yield curve for heart cut.

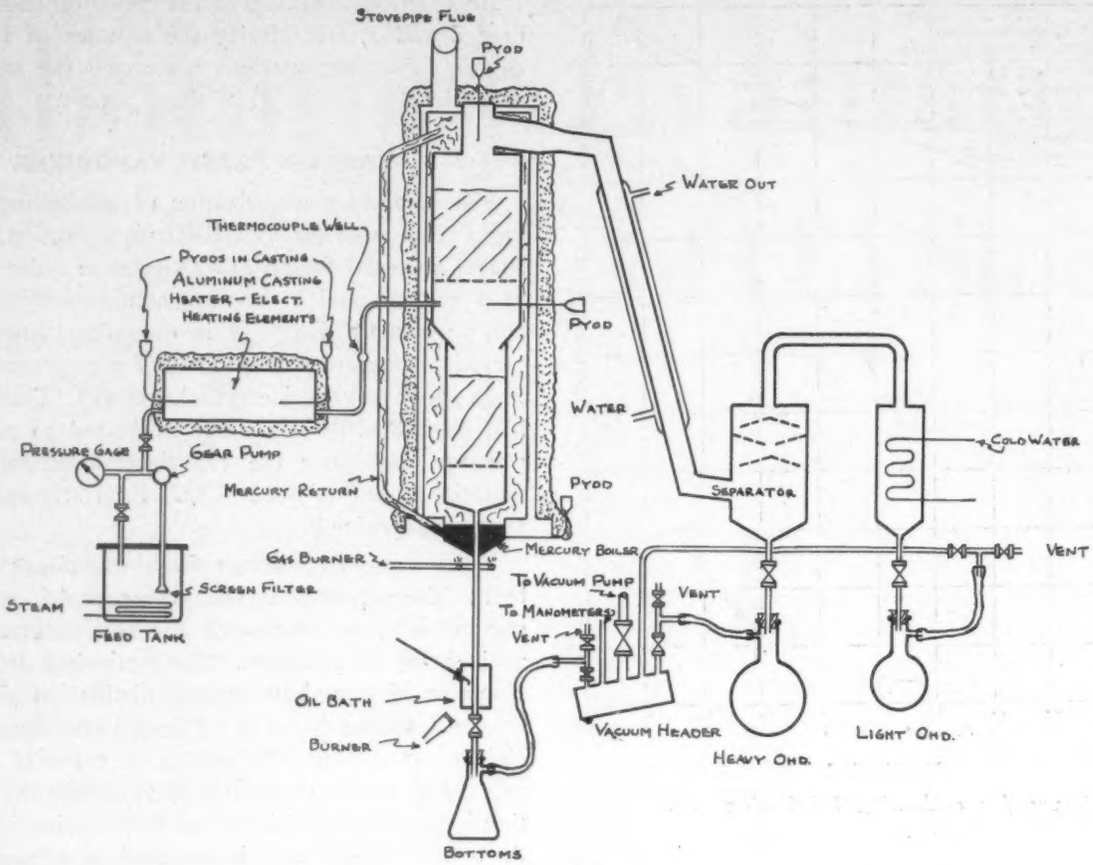


FIGURE 4
Continuous vacuum flash vaporizer.

regulator. The heat losses are abnormally large in laboratory equipment and hence the vaporizer is jacketed in mercury vapor and also by flue gas. The temperature of the mercury jacket can be controlled by regulating the pressure at which the mercury boils.

The distillate may be collected in two fractions by partial condensation. One of these is cooled by tap water but the other is cooled by circulating ice water or brine. If any low-boiling material, such as kerosene, is present in the sample, it tends to pass through both condensers and drop the vacuum on the system. The tar tends to solidify and it must be kept hot by means of an oil bath. The capacity of the equipment is about two gallons per hour.

REPLICA PLANTS

For the evaluation of many stocks semi-plant scale equipments or replica plants must be used. Cracking is one of the operations that cannot be handled in the laboratory except in a replica plant. Bombs and similar laboratory equipment have been widely used in the study of cracking but the results of such analyses do not check with plant yields. Most treating and dewaxing evaluations must also be handled by semi-plant scale equipment.

The outstanding usefulness of replica plants is in the obtainment of operating data. Laboratory analyses, such as those described heretofore do not disclose many of the operating conditions of a process. The one laboratory test that is useful in determining plant operating conditions is the flash vaporization curve. Flash vaporization data are about the only means that are now available for determining fractionating tower conditions, vaporization in pipe stills and designing condensers. The flash vaporization curve is used in the following phases of plant design:

(1) Pipe still outlet temperature and tower vaporizer temperature.
(2) Temperatures at top and side-draw plates of tower.
(3) Initial condensation temperature and condensation range in condensers.
(4) Vaporization and pressure drop in pipestills.

The replica or pilot plant is obviously useful in the development of new processes. Most processes are developed little by little by going from laboratory scale equipment to several sizes of replica equipment and finally to full commercial operation. During these developments the operating conditions are obtained so that the full scale plant can be confidently designed. Cracking processes are frequently studied in replica plants for the obtainment of operating data.

The disadvantages of the replica plant are (1) the equipment is expensive, (2) the cost of operation is high, (3) a large sample of oil is required, (4) the operation requires a relatively long time and (5) the

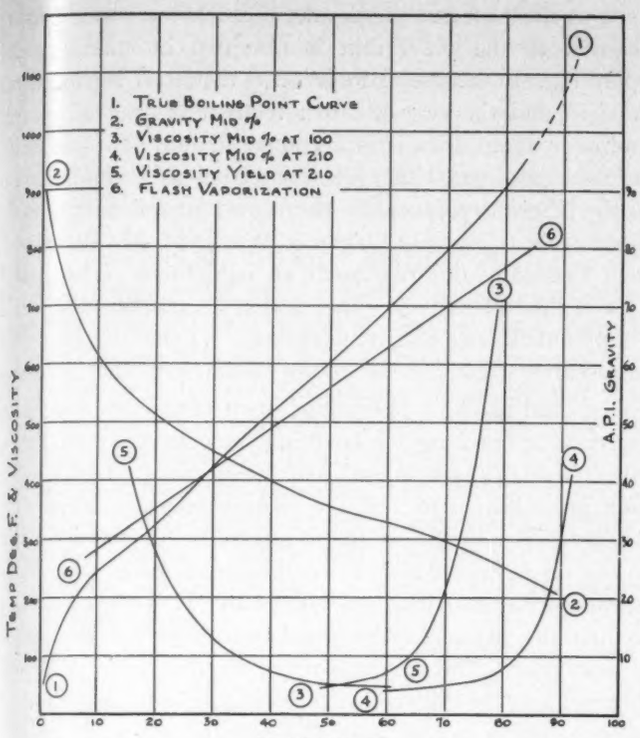

1. True Boiling Point Curve
2. Gravity Mid %
3. Viscosity Mid % at 100
4. Viscosity Mid % at 210
5. Viscosity Yield at 210
6. Flash Vaporization
Temp Deg. F. & Viscosity
A.P.I. Gravity

FIGURE 5

Evaluation curves for a 37.3 A. P. I. Mid-Continent crude oil.

plant is useful for only one operation. These disadvantages are of such a nature that only the most difficult evaluations are handled by replica plants. The cost of replica plants often reaches $2,000 per barrel of daily capacity although the cost varies greatly because of the many types of plants that are built. The cost is high, mainly because of the difficulties with control and because small pumps, heaters, connections, etc., are not stocked by manufacturing companies. The operation of the plant is expensive because several operators are necessary and long runs are common. Frequently it is necessary to spend more time adjusting the operating conditions and in learning to operate the plant than to conduct the test run. Finally the equipment is built for a special purpose and it is virtually useless for other operations. These disadvantages of the replica plant have led to the development of the more general evaluation methods that have been outlined in these articles.

TREATING AND DEWAXING

These operations are always troublesome. Most refinery laboratories have conducted hundreds of laboratory "treats" but with few exceptions they do not check with plant operations. The treating of light distillates, such as pressure still distillate and kerosene, is most successful but even in these the color seldom checks with the color of the plant product and the losses in the laboratory are large. In the acid treating of lubricating oil stocks the results are less satisfactory. However, by conducting a large number of treats over a period of years, it is possible to say whether a stock can be successfully treated in the plant even though the laboratory and plant results do not check. Difficulty arises because the treating operation cannot be controlled and because the sludge cannot be properly separated.

Light oils, such as gasoline and pressure distillate are usually treated in the laboratory by placing the sample in a bottle or jug and agitating it for 10 to 20 minutes by hand or in a mechanical agitator with sulphuric acid. The sludge is allowed to settle for several hours and is separated by decantation or by a separatory funnel. The settling time is sometimes shortened by centrifuging the "sour" oil for two or three minutes at a speed of 1500 R.P.M. The oil is ten neutralized with caustic soda or by a doctor treatment and washed with water. Treated pressure distillates must be distilled with steam or in a vacuum. The temperature is not allowed to exceed about 225° F. during the distillation. If many treats are conducted, special glass or iron stills may be used. These are usually of the batch type. An equipment for redistillation is discussed by Dailey, Meier & Shaffer[1] and a comparison of laboratory and plant results is given. A continuous treating apparatus for light distillates is described by Zublin[2].

The laboratory treating of lubricating oil stocks cannot be as easily systematized. However, Weir, Houghton & Majewski[3] have developed a standard method of treating lubricating oil stocks. The oil is measured directly into a 100 cc centrifuge tube and acid is added from a small graduated pipette. The tube is stoppered and either shaken by hand or in a mechanical shaking device. The shaker can be placed in a heated cabinet if the treating is to be conducted at a high temperature. The time for shaking ranges from 10 minutes for diluted samples to 40 or 60 minutes for viscous oils. The sludge and "pepper" sludge is then removed by centrifuging the tube for about one hour at 1500 R.P.M. The "sour" oil is then neutralized with ammonia gas, caustic soda or by contact clay.

Most laboratories finish their lubricating oils by contact treatment with Fullers earth. About 10 percent by weight or less of 200 mesh Fullers earth is mixed with the oil and heated to 450° F. for about 10 minutes. For neutral oils a temperature of 300° F. is used. The mixture is agitated with steam or shaking device and better color is obtained if the surface of the oil is protected from the air by a blanket of steam or inert gas. The clay is then filtered from the oil while hot by pouring it through a Buchner filter that is connected to a vacuum pump.

Lubricating oil stocks are frequently diluted to allow more intimate mixing and to facilitate settling of the sludge and filtration of the contacted oil. The material, usually naphtha, that is used as a diluent, must be removed by a distillation. Steam or a vacuum may be

[1] "Correlate Plant and Lab. Procedures for Distilling Acid Treated Cracked Naphtha," O.&G. J., p. 11, May 3 (1934).

[2] "Continuous Treating of Oils in the Lab." O.&G. J., last of November (1932).

[3] "Control of Color of Pet. Oils by Acid Treating," Refiner, p. 89, December (1930).

used and the temperature should be kept as low as possible. However, the distillation must be continued until a suitable flash-point is obtained.

In the study and treatment of oil stocks it is convenient to use a color scale that is directly proportional to the depth of color. The Atlantic Refining Company has developed such a color scale[3]. For stocks that are not diluted the relation between the True Color Scale and the N.P.A. scale is—

$$\text{N.P.A. Color} = 1.08\ C^{0.384}$$

The usefulness of such a scale is at once apparent. It may be used to compare crude oils or black cylinder stocks for the degree of blackness. It thus indicates the power of these materials to spoil the color of distillates by entrainment. It provides a means of comparing the actual decolorization during treatment. Thus a 20 True color is twice as dark as a 10 True color. Finally, it allows the color scale to be extended into the colors that are too dark for the ordinary scales by diluting with a colorless material.

The dewaxing of oil in the laboratory is also a troublesome operation. A common method is to dilute the oil (about 3 to 1) and chill it in packed ice and salt to about 30 degrees below the desired pour-point. About one ounce of filter aid per 100 cc of oil is added and the mixture is filtered through a Buchner funnel that is provided with an ice packed jacket and a cover. A vacuum is applied to the filter. A convenient method of chilling the oil is to use an ice cream freezer. Filter leaves are also widely used. These are constructed of very fine mesh monel metal screen and connected to a receiver and vacuum pump. Filter leaves provide a much larger surface than a Buchner filter. However, all laboratory methods of dewaxing are troublesome because filtration occurs so slowly, because the low temperature is hard to maintain and because the pour-point is never as low as desired.

Davis & Campbell[4] have developed a systematic method of studying wax distillate in the laboratory to determine its pressing characteristics. The examination consists of a vacuum distillation at 40 mm pressure, a determination of the viscosity at 100 and an examination of the crystal formation with a microscope. Their data indicate that material boiling up to about 650° F. at 40 mm pressure can be successfully incorporated in a wax stock. This corresponds to the temperature of about 885°F.at 760 mm pressure. They made a complete study of a wax distillate by analyzing it in a true boiling-point column and examining the wax fractions and blends of them.

EVALUATION OF CRACKING STOCK

No truly satisfactory method of estimating the yield of cracked gasoline that can be produced from a stock has been developed. Pressure bombs have been widely used in the past but the results of such tests bear little relation to the yield that is obtained in commercial operation. In commercial operation the stock is partially cracked and the recycle stock from it is cracked over and over again until it is decomposed into gas, tar and cracked gasoline. This cycle cannot be easily duplicated in the laboratory except by the use of a replica or semi-plant scale equipment. Gary & Ward[5] of M. W. Kellogg Company describe such an equipment. The cost of a replica plant is so great that it cannot be used for plant control tests and its usefulness is generally limited to research work and the design of new cracking plants.

For mild cracking operations, such as viscosity breaking tests or cracking for lowering the pour-point of fuel oils, the bomb equipments are satisfactory. The common procedure is to heat the oil in a pressure bomb of 820-860° F. for 10 to 30 minutes. The pressure rises as the oil is heated and when the pressure reaches 200 pounds per square inch the relief valve is opened a little so that the gas and some distillate can escape through a condenser. The distillate from the cracking is then distilled and the material that is not in the boiling range of gasoline is mixed with the cracked stock that remains in the bomb.

The following method of estimating the yields by cracking was developed by a study of plant yields. The yield is dirctly related to the change in gravity of the stock as it is cracked into tar. Thus, if the difference in the gravity of the stock and of the tar is great, a large yield will result and vice versa. The following equations[6] show this relationship:

Percent 400 E.P. gasoline from gas oil or fuel oil $= 25 + 1.5\ (A_s - A_t)$

Percent 400 E.P. gasoline by coking fuel oil $= 303 - 250_s$

Percent 400 E.P. gasoline by coking gas oil $= 331 - 300_s$

A_s = A.P.I. of cracking stock

A_t = A.P.I. of cracked tar

S = Specific gravity of cracking stock

For gas and unaccounted for losses—

Percent gas and unacounted for losses $= 0.45\ (A_s - A_t)$

In applying these formulas it is necessary to rely on experience in estimating what gravity of tar can be made without exceeding the viscosity specifications of fuel oil. The gravity of tars from cracking gas oil are

TABLE II.

Approximate Yields When Producing a 10° A.P.I. Tar by Cracking

A.P.I. Gravity of Stock	Stock	Percent 400 E.P. Gasoline	Percent Gas and Loss
15	Fuel Oil	32.5	2.25
20	Fuel Oil or Gas Oil	40.	4.5
25	Fuel Oil or Gas Oil	47.5	6.75
30	Gas Oil or Fuel Oil	55.	9.
35	Gas Oil	62.5	11.25
40	Distillate	70.	13.5
45	Naphtha	77.5	15.75

[4] "Lab. Control of the Quality of Paraffin Distillate," O.&G. J., p. 49, May 25 (1933).

[5] "A Modern Experimental Cracking Unit," Refiner, p. 212, June (1933).

[6] "Cracking," Petroleum Engineer, August (1933).

usually between 2° and 7° A.P.I. and from fuel oils, 5° and 9° A.P.I. If part of the fuel oil is not cracked so that the tar from the cracking process is a mixture of straight-run and cracked tar the gravity must be even higher (8-11° A.P.I.).

The yields that may be expected when producing a 10° A.P.I. tar, are shown in Table II.

REALIZATION OF CRUDE OIL

As a summary of the evaluation methods that have been described in these papers, a complete realization of a Mid-Continent 37.3° A.P.I. crude oil by topping, topping and cracking, and lubricating oil processing will be presented. The evaluation curves of this crude oil are shown in Figure 5. It will be necessary to refer to all three of the articles on laboratory evaluation to understand how the yields were determined. The realizations are computed for the market prices for the dates of October, 1933, and August, 1934. Table III shows seven realizations.

The value of products as shown in Table III should not be confused with the profits of refining. Three costs must be substracted from the above to estimate the profits of a refining operation. These are (1) cost of crude oil—$1.02 per barrel in October, 1933, and the same in August, 1934, (2) cost of processing—varies from $0.25 to $0.52 per barrel for the different modes of operation and (3) general refinery administration, sales, taxes, freight charges for crude and finished products and depreciation. Thus, the first three operations are hardly profitable and the success of the fourth depends upon finding a market for steam refined cylinder stock.

REFERENCES

Sydnor & Patterson—Ind. Eng. Chem. 22:1237 (1930), Experimental cracking plant and results of operation.

LeRoi & Ferguson—"Developments in Naphtha Reforming Practice for Octane Number Improvement," 3rd Mid-Year Meeting of A.P.I., Tulsa (1933).

Conine—"Refiners of Pennsylvania Grade Crude Support Research to Further Improve Their Products," Oil & Gas Journal, page 15, November 16 (1933), Equipment used in studying solvent extraction.

TABLE III.

PRODUCTS	Yield—Percent Untreated	Yield—Percent Finished	Value at Refinery $ per Bbl. October, 1933	Value at Refinery $ per Bbl. August, 1934
1. Simple Topping:				
Gasoline 60–62 400 E.P. Reg.	28*	27.5	.577	.462
Kerosene 42–44	13	12.5	.19	.177
Fuel Oil 28 A.P.I.	58	58	.487	.464
Loss Assumed	1	2	.....	.....
			1.254	1.103
2. Topping through Gas Oil:				
Gasoline U.S. Motor Reg.	34	33	.658	.555
Kerosene 41–43	4.5	4.5	.066	.060
Gas Oil—Cracking Stock	34	34	.214 (est.)	.286
Fuel Oil 20–22	26	26	.142	.182
Loss (assumed)	1.5	2.5	.....	.....
			1.08	1.083
3. Topping and Cracking:				
Gasoline 60–62 400 E.P. Prem.	57†	55	1.01	1.06
Kerosene St. Run 42–44	13	12.5	.19	.177
Furnace Oil 39–41 Straw	4	4	.05	.042
Fuel Oil 8–9	18	18	.091	.117
Loss and Gas	8	10.5	.....	.....
			1.341	1.396
4. Long Residuum Operation:				
Gasoline 60–62 400 Reg.	28	27.5	.577	.462
Kerosene 42–44	13	12.5	.19	.177
Gas Oil 32–36 0–15 C.T.	25	25	.236	.263
S.R. Cyl. Stock 100–120 vis. 600F1	32	31	.814	.91
Loss (assumed)	2	4	.....	.....
			1.817	1.812
5. Lubricating Oil I (Vacuum)				
Gasoline 60–62 400 Reg.	28	27.5	.577	.462
Kerosene 42–44	13	12.5	.19	.177
Gas Oil 32–36 0–15 C.T.	22	22	.208	.231
Neutral 150 vis. 3 Color	5	5	.152	.21
Neutral 400 vis. 4 Color	10	9	.557	.652
Bright Stock 190–200 vis. D	16.6	13.3	1.34	1.12
Solid Tar (by vacuum)	4	4	.....	.....
Loss—Sludge, Wax, etc.	1.4	6.7	.....	.....
			3.024	2.852
6. Lubricating Oil II (Vacuum):				
Gasoline 60–62 400 Reg.	28	27.5	.577	.462
Kerosene 42–44	13	12.5	.19	.177
Gas Oil 32–36 0–15 C.T.	22	22	.208	.231
Neutral 200 vis. 3 Color	12	10.2	.386	.505
Bright Stock 150–160 vis. D Color 0–10 C.T.	20	16.5	1.56	1.18
Solid Tar (vacuum)	4	4	.....	.....
Loss—Sludge, Wax, etc.	1	7.3	.....	.....
			2.921	2.555
7. Lubricating Oil III (Residuum):				
Gasoline 60–62 400 Reg.	28	27.5	.577	.462
Kerosene 42–44	13	12.5	.19	.177
Gas Oil 32–36 0–15 C.T.	19	19	.179	.199
Neutral 150 vis. 3 Color	11	9.4	.286	.394
Bright Stock 150–160 vis. D color 0–10 C.T.	26	15.8	1.48	1.13
Loss—Sludge, Wax, etc.	3	15.8	.....	.....
			2.712	2.362

*Some used to lower initial of kerosene.
†Estimated from equations.

Cooling Water Supply Secured By Gas Lift

THE problem of maintaining a sufficient and constant supply of water at any gasoline plant is one that must be solved, regardless of the location of the plant or the source from which the water is produced. When wells must be depended upon to furnish a volume of water sufficient for the daily needs of plant cooling and boiler consumption, they may either be pumped or produced by lifting the water with gas pressure. When water is brought to the surface by the latter method, very few gasoline plants deem it expedient to recover the gas coming from the well with the water. Often there is a surplus of gas and a riser is placed at some point in the system through which the gas is vented.

Westoak Gasoline Company, however, at its plant near Sayre, Beckham County, Western Oklahoma, recovers the gas by separating it after it has been used in lifting water from wells in the plant yard. in this case, the system of producing the gas from the wells in the Sayre field requires a careful check of the amount that is produced, because of the fact that all residue remaining after the initial amount has been processed is passed through pipe lines to a carbon black plant owned by the same company. Gas is not produced from any of the wells in that area from which the gasoline plant supply is taken, excepting during the time the carbon black plant is operating, and as a consequence, all gas passed through the plant must be accounted for whether it is used in burning flambeaus, torches, or used for fuel or gas lift.

Water is plentiful in that district, but a supply sufficiently low in scale forming solids is secured only by the drilling of deep wells, and as the residue pressure of the gas after it has passed through the absorbers and after scrubbers averages around 290 pounds, the production of water for plant consumption is accomplished by applying gas lift. The wells are drilled and tubed in the regulation manner and produced as other wells are produced, but the difference lies in the manner in which the water is handled and the disposition of the gas after it has served its purpose in lifting the water.

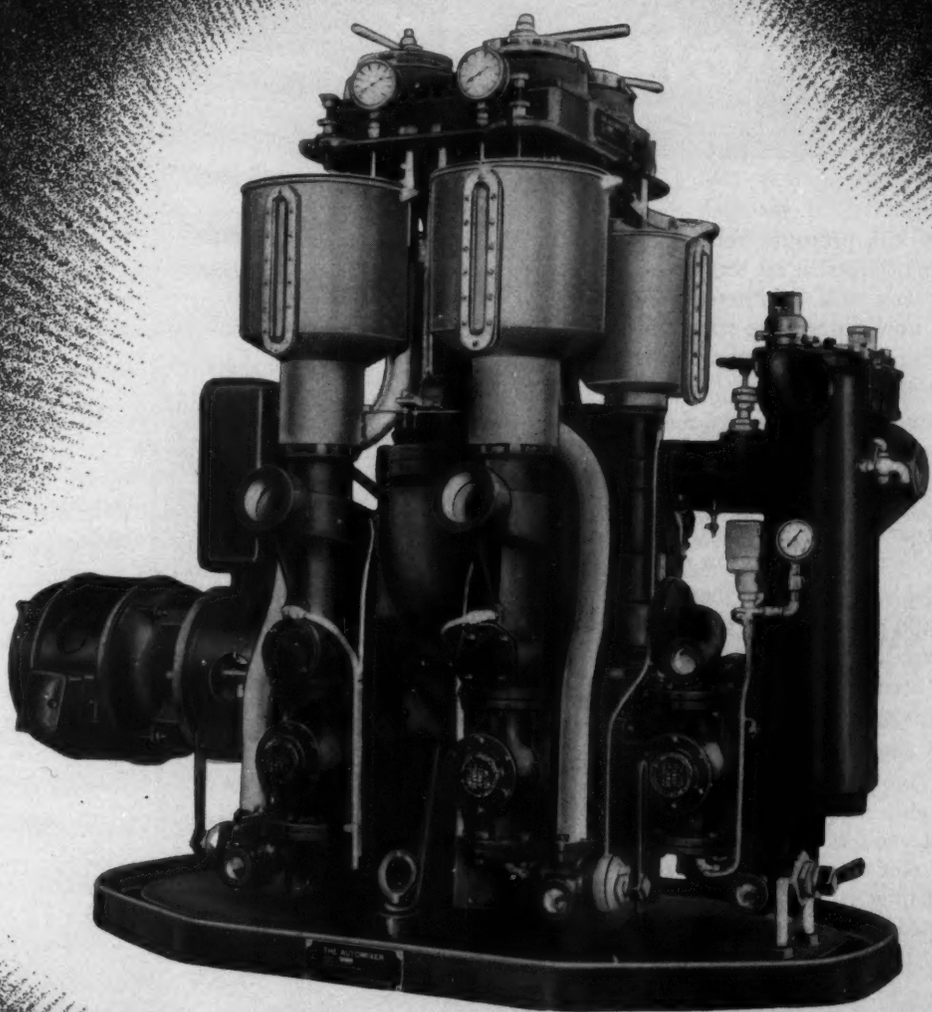
After the wells have been tubed and the necessary equipment assembled with which to flow the wells, a four inch flow line is laid from the tubing head at the well to a vertical scrubber, placed in this instance, between the well and the basin of the louvre tower. This scrubber, or gas and water separator is a closed vessel, made from an accumulator tank. Several openings were originally provided for prior service, and others were welded to it so it could be used for the purpose of separating the gas from the water automatically. The four-inch flow line leading from the well is connected to a welded collar placed near the head of the separator on the well side, and the outlet connection is welded near the center of the sparator, 90 degrees around from the inlet. The gas vent line takes off from a connection in the center of the upper head, and that line leads to the engine room fuel header.

Water drained constantly from this separator is controlled by a float operated valve so that the separator always remains about half full. A float controlled outlet valve on this piece of equipment prevents surging of the water, and prevents gas from passing to the louvre tower basin should the flow of water from the separator exceed the amount provided by the flowing well. This control is placed on the side of the vessel in the conventional manner and a frost box placed around it to prevent it from freezing in winter.

The wells producing water at this plant are operated at all times while gas is being produced from the field and the plant operated, and the surplus water lifted from the wells above that consumed by the boilers and dissipated through wind losses and evaporation is allowed to flow through a drain in the side of the louvre tower basin and to waste. This practice prevents the water circulated through the exchangers and over the cooling sections from becoming unduly saturated with scale forming solids. It not only provides a constant supply of make up water, but also assists in maintaining a low temperature of the cooling water.

No attention is required in operating this system except occasionally blowing down the separator to prevent accumulation of sand that might be produced with the water. Gas is automatically removed from the relief line coming from the upper head, flowing through the fuel reduction valve into the fuel header at the engine room. The fuel used in this engine room is consumed in internal combustion engines operated to drive generators which provide power to operate the pumps in the gasoline plant, and to provide lighting and power in the carbon black plant. A meter is placed on the fuel line to determine the amount of gas used in lifting the water, which records the consumption of gas.

THE Automixer



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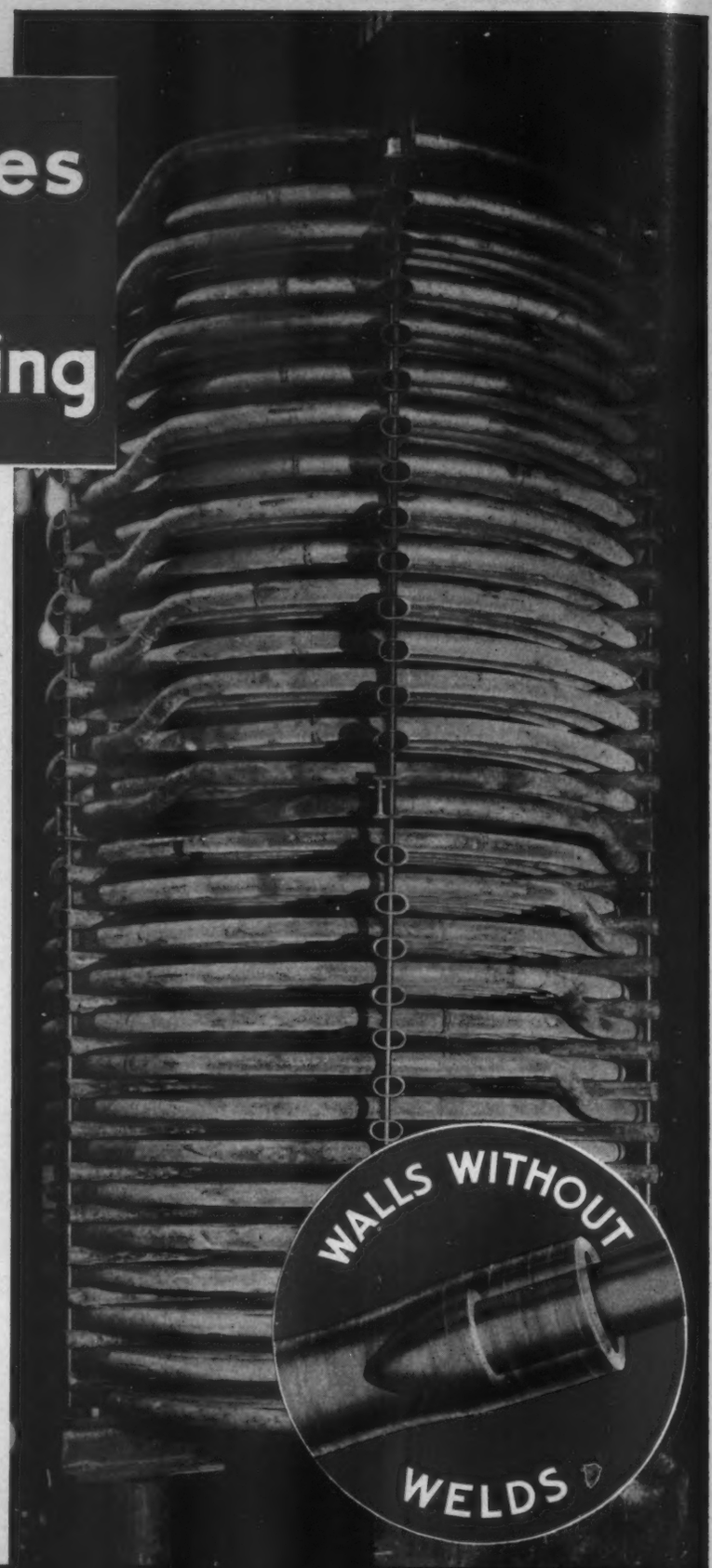

If you have to do with pressures, temperatures, or corrosive conditions that are too severe for ordinary material, you will be interested in a typical example of how progressive refineries are meeting the demand for modern equipment to meet modern refining needs.

The coil shown is one of a pair, each 16 feet high and 8 feet in diameter. It contains approximately 2600 feet—nearly a half mile—of 2-⅞-inch O. D. National Tube Company 4%-6% Chromium Still Tubing with ½% Molybdenum, and weighs 16 tons. After fabrication was completed the coil was subjected to a hydrostatic test of 2000 pounds and an air test of 400 pounds. Not a sign of any fault or weakness was to be found. The pair of these coils will be used in the evaporator tower of one of the largest refineries.

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(*Continued from page 86*)

That executive, acquainted as he is with every type of position in the refining industry, knows what key men are, knows the prerequisites and qualifications for such positions, knows the trail that leads away from them upward to better jobs, and knows full well that trained man or practical man being trained, can not move upward without conscientious study of his industry, its development and rapid technical progress. So he insists that key men, or men with ambitions, in his organization, read and study at least one technical journal devoted to the industry. Or his organization will be revamped. His point is well taken.

A.I.M.E. Petroleum Division Elections

DURING the annual meeting of the American Institute of Mining and Metallurgical Engineers, held in New York February 18-21, announcement was made of the election of new officers and members of the executive committee of the petroleum division of the institute. The new officers are as follows: Harry H. Power, Gypsy Oil Company, Tulsa, chairman; John F. Dodge, associate chairman; and Eugene A. Stephenson, secretary-treasurer.

The new executive committee will consist of Harry H. Power, chairman, and the following members: A. W. Ambrose, Empire Companies, Bartlesville, Okla.; E. O. Bennett, Continental Oil Company, Ponca City; E. G. Gaylord, Standard Oil Company of California, San Francisco; H. J. Wasson, consulting engineer, New York; and H. D. Wilde, Jr., Humble Oil & Refining Company, Houston.

M. Albertson, Shell Petroleum Corporation, Houston, was elected vice chairman for production engineering, and each of the following as associate vice chairman for production engineering: Robert E. Allen; Douglas Collingwood and L. L. Foley.

J. Terry Duce, The Texas Company, New York, was chosen vice chairman for production and Benjamin C. Craft associate vice chairman for production.

Other new vice chairmen will include T. V. Moore, Humble Oil & Refining Company, Houston, for engineering research; Sidney A. Swensrud, Standard Oil Company of Ohio, Cleveland, Ohio, for economics; and Walter Miller, Continental Oil Company, Ponca City, for refinery engineering.

Earl Oliver, Ponca City, Oklahoma,

The Look Box

will serve as chairman of the stabilization committee.

The 9000 members of the general institute itself chose as officers for the coming year: Henry A. Buehler, president; John M. Lovejoy and Paul D. Merica, vice presidents. Buehler replaces the retiring president, Howard N. Eavenson. The new president is state geologist and director of the Missouri Bureau of Geology and Mines.

Conventions

W. P. R. A. The Western Petroleum Refiners Association on April 4 and 5 will hold its annual meeting at Excelsior Springs, Mo., at the Elms Hotel.

Exposition. The Sixth Annual Oil Equipment & Engineering Exposition will be held at Houston, Texas, April 8 to 13.

P. I. E. A. The Petroleum Industry Electrical Association will convene at the Hotel Baker, Dallas, Texas, April 11 to 13.

N. P. A. The National Petroleum Association will hold its semi-annual meeting, Hotel Cleveland, Cleveland, Ohio, April 18 and 19.

A. C. S. Beginning April 22, American Chemical Society will hold its semi-annual meeting in New York City.

N. G. A. May 1, 2, 3, Natural Gasoline Association of America will hold its annual meeting at the Tulsa Hotel, Tulsa, Oklahoma.

A. I. C. E. May 14-16, American Institute of Chemical Engineers will meet for its semi-annual convention in Wilmington, Delaware.

A. P. I. American Petroleum Institute will hold its fifth mid-year meeting in the Mayo Hotel, in Tulsa, May 14, 15, 16.

P. G. C. O. A. Pennsylvania Grade Crude Oil Association plans to hold its annual convention at State College, Pennsylvania, June 20 and 21.

A. S. T. M. American Society for Testing Materials annual meeting is scheduled for June 24 to 28 at the Book Cadillac Hotel, Detroit, Michigan.

N. P. A. The National Petroleum Association, September 25-27, will hold its annual meeting at Atlantic City, at Hotel Traymore.

A. P. I. The American Petroleum Institute will hold its 16th annual meeting at the Biltmore Hotel, Los Angeles, November 11-14.

C. N. G. A. The California Natural Gasoline Association holds its meeting the first Thursday of every month in the Richfield Building, Los Angeles, California.

Motor Fuel Research Committee Announced

R. E HAYLETT, chairman of the Central Committee on Refinery Technology, has appointed the following members to the Motor Fuel Research Committee:

R. P. Anderson, American Petroleum Institute, New York, chairman; D. P. Barnard, IV, Standard Oil Company, (Indiana), Whiting, Ind.; A. E. Becker, Standard Oil Development Company, New York; H. W. Camp, Empire Oil & Refining Company, Tulsa; A. Ludlow Clayden, Sun Oil Company, Philadelphia; T. G. Delbridge, The Atlantic Refining Company, Philadelphia; Graham Edgar, Ethyl Gasoline Corporation, New York; E. W. Isom, Sinclair Refining Company, New York; K. G. Mackenzie, The Texas Company, New York; Walter Miller, Continental Oil Company, Ponca City, Oklahoma; C. C. Moore, Jr., Union Oil Company of California, Los Angeles; G. G. Oberfell, Phillips Petroleum Company, Bartlesville, Oklahoma; J. T. McCoy, Tide Water Oil Company, Bayonne, N. J.; J. B. Rather, Socony-Vacuum Oil Company, New York; T. B. Rendel, Shell Petroleum Corporation, Wood River, Illinois; H. G. Smith, Gulf Refining Company, Philadelphia; G. R. Taylor, McColl-Frontenac Oil Company, Montreal; J. B. Terry, Standard Oil Company of California, San Francisco; and C. R. Wagner, The Pure Oil Company, Chicago.

Parsons to Head A. P. I. Committee

L. W. PARSONS, Tide Water Oil Company, New York, has been appointed chairman of the program committee of the Division of Refining, W. G. Skelly, chairman of the general committee of the American Petroleum Institute's Division of Refining, has announced. Dr. R. P. Anderson, American Petroleum Institute, New York, is secretary of the committee, which is composed of the following members:

H. W. Camp, Empire Oil & Refining Company, Tulsa; R. A. Halloran, Standard Oil Company of California, San Francisco; R. T. Haslam, Standard Oil Development Company, New York; R. E. Haylett, Union Oil Company of California, Los Angeles; E. W. Isom, Sinclair Refining Company, New York; K. G. Mackenzie, The Texas Company, New York; Walter Miller, Continental Oil Company, Ponca City; Arthur E. Pew, Jr., Sun Oil Company, Philadelphia; J. B. Rather, Socony-Vacuum Oil Company, New York;

Herschel G. Smith, Gulf Refining Company, Philadelphia; F. W. Sullivan, Jr., Standard Oil Company (Indiana), Chicago; F. W. L. Tydeman, Shell Development Company, San Francisco.

Pew Heads Refinery Equipment Committee

ARTHUR E. PEW, JR., Sun Oil Company, Philadelphia, has been named chairman of the Committee on Standardization of Refinery Equipment, together with the following members:

R. P. Anderson, American Petroleum Institute, New York, secretary; D. G. Brandt, H. L. Doherty & Company, New York; L. L. Davis, Continental Oil Company, Ponca City; E. W. Gard, Union Oil Company of California, Los Angeles; W. M. Giffen, Shell Oil Company, San Francisco; J. G. Glasgow, Gulf Refining Company, Pittsburgh; A. J. Ely, Standard Oil Development Company, Elizabeth; John S. Hess, Sinclair Refining Company, New York; K. V. King, Standard Oil Company of California, San Francisco; W. D. Kinsell, The Pure Oil Company, Chicago; R. C. Powell, The Texas Company, New York; Walter Samans, The Atlantic Refining Company, Philadelphia; and George W. Watts, Standard Oil Company (Indiana), Whiting.

A. P. I. Committee on Accident Prevention Named

R. E. HAYLETT, chairman of the Central Committee on Refinery Technology of the American Petroleum Institute, has appointed the following to membership on the Committee on Accident Prevention in Refineries:

C. W. Smith, Standard Oil Company (Indiana), Chicago, chairman; H. N. Blakeslee, American Petroleum Institute, Dallas, secretary; C. P. Anderson, Richfield Oil Company, Los Angeles; J. C. Bernd, Sinclair Refining Company, East Chicago; R. W. Black, Standard Oil Company of New Jersey, Elizabeth; J. C. Boylan, Continental Oil Company, Ponca City; J. H. Brown, Tide Water Oil Company, New York; Glenn Byers, Shell Petroleum Corporation, St. Louis; C. W. Coleman, Gulf Refining Company, Port Arthur; R. E. Donovan, Standard Oil Company of California, San Francisco; J. H. Herbert, Standard Oil Company (Ohio), Cleveland; D. B. Hiatt, Texas Pacific Coal & Oil Company, Fort Worth; L. F. Knox, General Petroleum Corporation, Los Angeles; W. F. Lowe, Natural Gasoline Association of America, Tulsa; S. H. McKenty, The Atlantic Refining Company, Philadelphia; C. J. Nobmann, Shell Oil Company, San Francisco; A. A. Odell, Barnsdall Oil Company, Tulsa; G. F. Prussing, Union Oil Company of California, Los Angeles; W. P. Reymond, Jr., Standard Oil Company of Louisiana, Baton Rouge; C. L. Swim, Skelly Oil Company, Tulsa; and A. A. Nichoson, The Texas Company, New York.

Committee on Corrosion of Refinery Equipment Named

R. E. HAYLETT, chairman of the American Petroleum Institute's Central Committee on Refinery Technology has appointed Walter Samans, Atlantic Refining Company, Philadelphia, chairman of the Committee on Corrosion of Refinery Equipment, and D. V. Stroop, American Petroleum Institute, New York, secretary.

Others appointed to the committee include:

A. B. Bagsar, Sun Oil Company, Philadelphia; F. C. Braun, Gulf Refining Company, Pittsburgh; L. L. Davis, Continental Oil Company, Ponca City; E. S. Dixon, The Texas Company, Port Arthur; R. L. Duff, Standard Oil Development Company, Elizabeth; W. M. Giffen, Shell Oil Company, San Francisco; J. W. Griswold, Crew Levick Company, Philadelphia; A. E. Harnsberger, The Pure Oil Company, Chicago; K. V. King, Standard Oil Company of California, San Francisco; J. T. McCoy, Tide Water Oil Company, Bayonne; L. G. Metcalf, Union Oil Company of California, Los Angeles; J. W. Newton, Magnolia Petroleum Company, Beaumont, Texas; J. E. Pollock, Humble Oil & Refining Company, Baytown, Texas; Jos. K. Roberts, Standard Oil Company (Indiana), Whiting; and T. D. Tifft, Sinclair Refining Company of New York.

Trelford to Head A. P. I. Committee

O. D. DONNELL, chairman of the American Petroleum Institute's Central Committee on Standard Procedure for Measuring, Sampling and Testing Crude Oil has appointed W. R. Trelford of Humble Oil & Refining Company, Houston, as chairman of the Correlating Sub-Committee, together with the following members:

C. A. Young, American Petroleum Institute, Dallas, secretary; E. L. Adams, General Petroleum Corporation of California, Los Angeles; R. P. Anderson, American Petroleum Institute, New York; D. S. Bushnell, Northern Group of Pipe Lines, New York; H. W. Camp, The Empire Companies,

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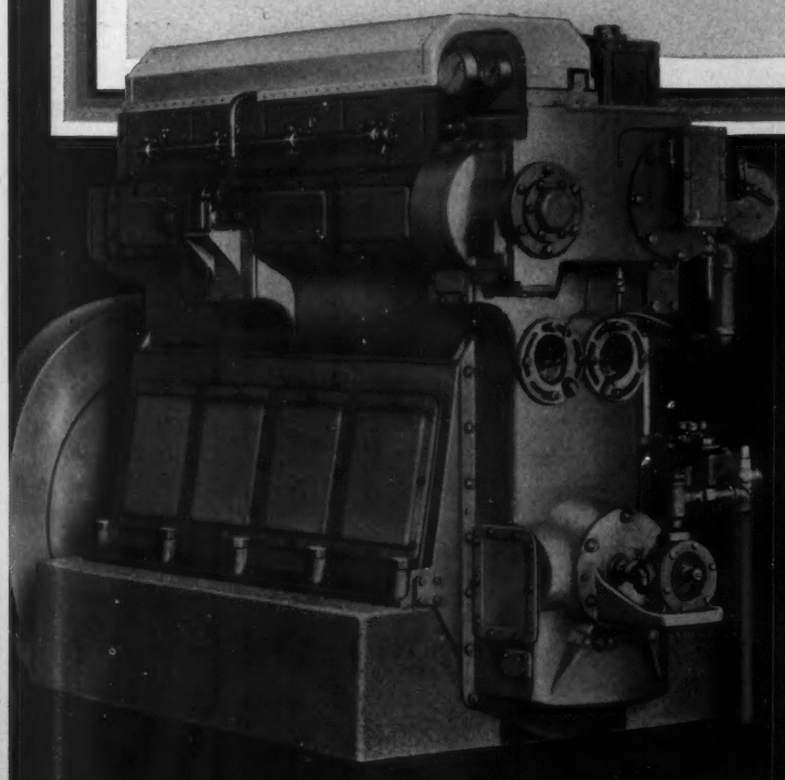

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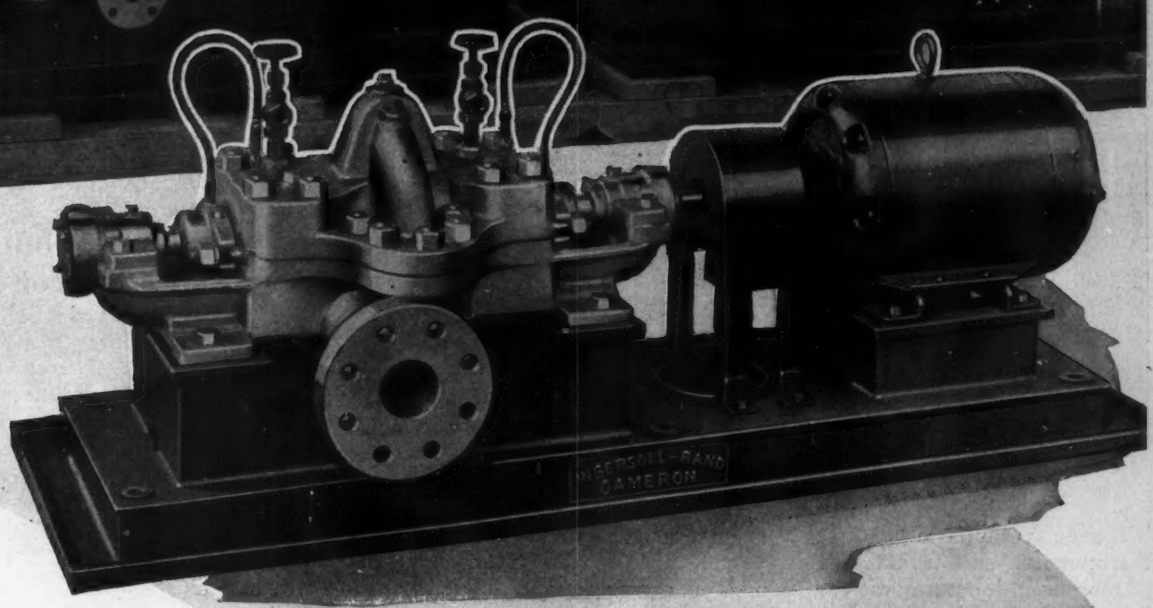

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Tulsa; Geo. H. Forster, Union Oil Company of California, Los Angeles; Wm. Groundwater, Union Oil Company of California, Los Angeles; Robert F. Hand, Standard Shipping Company, New York; E. R. Lederer, Texas Pacific Coal & Oil Company, Fort Worth; A. S. Bailey, Texas Pipe Line Company, Houston; L. W. Parsons, Tide Water Oil Company, Bayonne; Ray F. Shumaker, Prairie Pipe Line Company, Independence; L. L. Betchel, Stanolind Pipe Line Company, Casper; J. B. Terry, Standard Oil Company of California, San Francisco; C. R. Weidner, Prairie Pipe Line Company, Independence; and John R. Evans, Stanolind Oil & Gas Company, Casper.

Crude Production Allowable Decreased

A DECREASE of 5800 barrels daily in the national allowable crude oil production was authorized for March by Oil Administrator Harold L. Ickes. March's daily production was placed at 2,520,300, as compared with 2,526,100 barrels daily authorized for February.

The Bureau of Mines and the Petroleum Administrative Board in recommending the allowable to Administrator Ickes under the terms of the Oil Code, set forth that the slight decrease was occasioned by the comparable decrease in gasoline production necessary to meet current demand as to provide adequate inventory conditions for the opening of the spring trade season.

The largest decrease was authorized for Texas, a cut of 11,600 barrels to 1,020,100. Other allowables including some increases as well as decreases, follow:

Arkansas, off 100 to 31,900; California, up 4000 to 492,600; Colorado, unchanged at 3500; Illinois, off 500 to 11,200; Indiana, unchanged at 2200; Kansas, up 1100 to 139,700; Kentucky, down 100 to 14,700; Louisiana, up 1000 to 110,500; Michigan, up 1600 to 31,600; Montana, unchanged at 9500; New Mexico, down 100 to 49,300; New York, up 1000 to 11,300; Ohio, down 200 to 11,500; Oklahoma, down 6100 to 491,000; Pennsylvania, up 4300 to 43,300; West Virginia, up 300 to 11,300 and Wyoming, down 400 to 35,100.

Gasoline Production Allocation for March

THE allowed production of gasoline by refinery districts (including the production of straight run and cracked gasoline and the natural gasoline blended therewith, either at refineries or terminals) has been determined, in accordance with Section 3, Article IV of the Code to be, for the month of March, 1935, as follows:

District	Allocation to Meet Current Demand Barrels	Allocation for Seasonal Stock Increase Barrels
1. East Coast	5,331,000	603,000
2. Appalachian	1,517,000	140,000
3. Indiana-Illinois-Kentucky	5,015,000	801,000
4. Oklahoma-Kansas-Missouri	4,475,000	300,000
5. Texas:		
(a) Inland Texas	1,899,000	114,000
(b) Texas Gulf Coast	6,596,000	718,000
(c) East Texas	618,000	None
6. Louisiana-Arkansas:		
(a) Louisiana Gulf Coast including Alabama	1,170,000	41,000
(b) North Louisiana-Arkansas including Mississippi	710,000	20,000
7. Rocky Mountain	676,000	203,000
8. California	4,913,000	None
	32,920,000	2,940,000
Total United States	35,860,000 barrels	

Alcohol Inferior and More Expensive Than Gasoline

ALCOHOL is much inferior, gallon for gallon, to gasoline as a motor fuel. It is deficient in thermal or energy value, and costs much more than gasoline.

"Advocates of alcohol motor fuel advocate it largely as a special kind of

...trying to Maintain Correct Temperatures?

It's enough to make any man dizzy to keep jumping from thermometer to thermometer and from valve to valve. Does it pay to make machines out of men when temperatures can be maintained more accurately and cheaply with Sarco Temperature Regulators? Men can be used more profitably on other work.

Set a Sarco for any temperature between 0 and 300°F. and it will automatically maintain that temperature without attention. No chance of a Sarco forgetting or making a mistake. No danger of spoilage.

SARCO TEMPERATURE REGULATORS

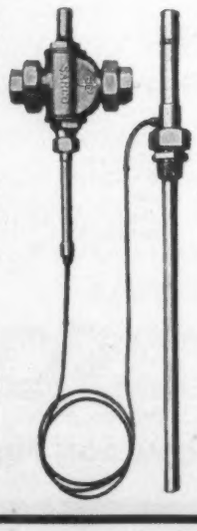
have the same sensitivity at all points of the range from zero up because they are operated by liquid expansion.

They are safe against overheating.

The packless sealed valve stem eliminates stuffing boxes and stem leakage.

Sarco Regulators are inexpensive to install and maintain because they are entirely self-contained and require no outside attachments or operating mediums. They work with equal efficiency on steam, gas or oil.

Furnished chrome-nickel trimmed without extra cost up to 2 inch size. Let us send you one on 30 days' free trial. Write for Catalog S-52.



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"—the gasoline derived from this cracking plant is in the highest bracket selling for 1 to 2 cents more per gallon"—a Mid-continent refiner in
REFINER AND NATURAL GASOLINE MANUFACTURER

He was referring to his new Dubbs unit

What would it be worth to you to get 1 to 2 cents more per gallon for your gasoline?

Figure it out on the basis of your own operations

Dubbscracking is the way to do it

Universal Oil Products Co
Chicago Illinois

Dubbs Cracking Process
Owner and Licensor

subsidy to the farmer, and usually make the mistake of comparing the plant manufacturing cost of alcohol, now about 22 cents per gallon if made from the cheapest material, molasses, with the distributed or filling station price of gasoline. All material from which alcohol can be made by fermentation has a food value for man, or cattle (with the exception of sawdust, conversion of which to alcohol has been an economic failure).

"The cheapest industrial alcohol, by fermentation, is that made from molasses, and the world's production of molasses would produce only 1.6 percent of our domestic motor fuel requirements. The use of any other material for alcohol manufacture, corn, potatoes or the like, would give much greater alcohol costs; and our entire corn crop at about 3,000,000,000 bushels, if used entirely for this purpose, would yield not quite half of our motor fuel requirement.

"The second report of the Federal Oil Conservation Board points out that corn at 45 cents per bushel is equivalent to alcohol at 23 cents per gallon, not including interest on the investment, depreciation of the plant, distribution cost, denaturing cost, or profit to the producer, distributor, or retailer." Benjamin T. Brooks, consulting chemist, writing in "Economic Forum," 1935 Winter Edition.

Fisher Governor Company spends thousands of dollars each year in research to develop better materials and improved methods of control.

To insure your complete satisfaction, every FISHER Automatic Control is guaranteed tested under actual pressure and operation conditions as specified on your order. These most modern factory facilities have been developed through fifty-five years of successful manufacturing. It costs but little more to buy guaranteed tested controls, and they are much less expensive in the long run.

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Penn Crude Association Approves Year's Plans

THE program of investigational work to be carried on at the Pennsylvania State College during the current year has been approved by the board of directors of Pennsylvania Crude Oil Association. Research will be conducted in two major divisions of the college, the Petroleum Refining Laboratory and the Mechanical Engineering Laboratory.

Investigations in solvent refining practices will be a major part of the work in the Petroleum Refining Laboratory. The particular line on which this project is to be conducted is experimental work to determine what solvents can be best applied to Pennsylvania oils. It has been contended that solvents best suited for use in refining Mid-Continent crudes may not be suitable for Pennsylvania crudes, since the refiner in the west is primarily concerned with the removal of asphaltic materials. The absence of roofing and paving materials in Pennsylvania crude means an entirely different problem for that refiner and, consequently, it is likely that the best results for him may be obtained by other methods or solvents. Fundamental studies in the use of solvents and further development of processing apparatus and in solvent efficiencies are provided for in the year's research program.

Special attention is being given to the profitable utilization of bright stock by which it may be possible to render refinery operations more flexible. The laboratory will continue previously inaugurated studies on the effects of oxidation and the perfection of oxidation tests and various means for further elimination of sludge-forming tendencies in lubricating oils.

Another project to be continued, which was authorized late last year, will be the development of a test index by which performance values of solvent refined neutral oils can be measured.

In the Mechanical Engineering Laboratory the staff is rapidly bringing the battery of engines to a point where they can be regarded as dependable test instruments for checking in advance the efficiency of any given oil. Engine runs will be continued, and, in addition more work will be done in the

Tame this *PROFIT-DEVOURING MONSTER* with ENDURO

REPUBLIC'S PERFECTED STAINLESS AND HEAT-RESISTING STEELS

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When corrosion and oxidation at high temperatures start eating into profits, it's time to consider seriously the advisability of changing to a metal that will staunchly resist these destroying forces. • Many analyses of ENDURO, Republic's Perfected Stainless and Heat-Resisting Steels, are now available. There is a grade to meet practically every condition of refinery service where corrosion must be minimized and strength maintained at high temperatures over long periods. The various grades cover an operating temperature range exceeding 2100° F., and permit a selection of the grade most economical for each type of service. • All grades show operating economy over ordinary steel—in still tubes, condenser tubes, heat transfer equipment, bubble caps, trays, plates, tube supports, pump parts, fittings and valves.

ENDURO 4-6% Chromium with Molybdenum, while not in the stainless family, finds a host of important applications in oil refining. • ENDURO is available in billets and tube rounds for use by equipment manufacturers, in electric weld tubing, plates, sheets, strip, rods, nuts, bolts, rivets and other forms used in refinery construction. • Write for complete information.

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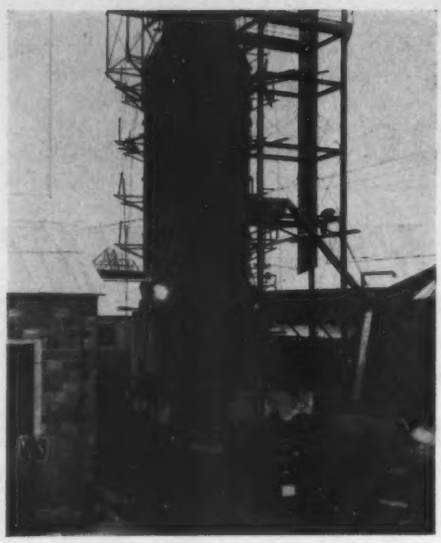
examination of oiliness characteristics in Pennsylvania and competitive lubricants.

Throughout the entire program, objectives of the technical committee, which guides investigational work at the college, are held to the definite purpose of determining how Pennsylvania oils can reach practical perfection. The technical committee believes this can best be accomplished through group research at the college.

Bubble Tower Grows 2¾ Inches in Service

A BUBBLE tower which grows 2¾ inches taller in service and which is the first of its type to be built under the new vacuum code is under construction at Maurer, New Jersey, for Barber Asphalt Company. This equipment is part of a vacuum distillation unit designed and installed by The Lummus Company for production of asphalt. The tower is being erected by the Chicago Bridge and Iron Works. It is of arc welded construction throughout.

The tower is 55 feet high, 15 feet diameter and will operate at 650°F. under vacuum. At this high temperature the structure is 2¾ inches taller than when cold. It is being fabricated in the field with the exception of the bonnet.



Vacuum tower under erection at the Barber Asphalt Company's Maurer, N. J. refinery which is first of its kind to be erected under the new vacuum code.

The shell is built of steel plates ranging from seven-eighths-inch thick at the bottom to three-quarters-inch thick at the top. All joints in the shell are butt joints. In the horizontal joints the plates are vee'd to 45 degrees with one-eighth-inch point. In the vertical joints the plates are vee'd to 60 degrees. All joints in the shell are welded with five-thirty-second-inch electrode.

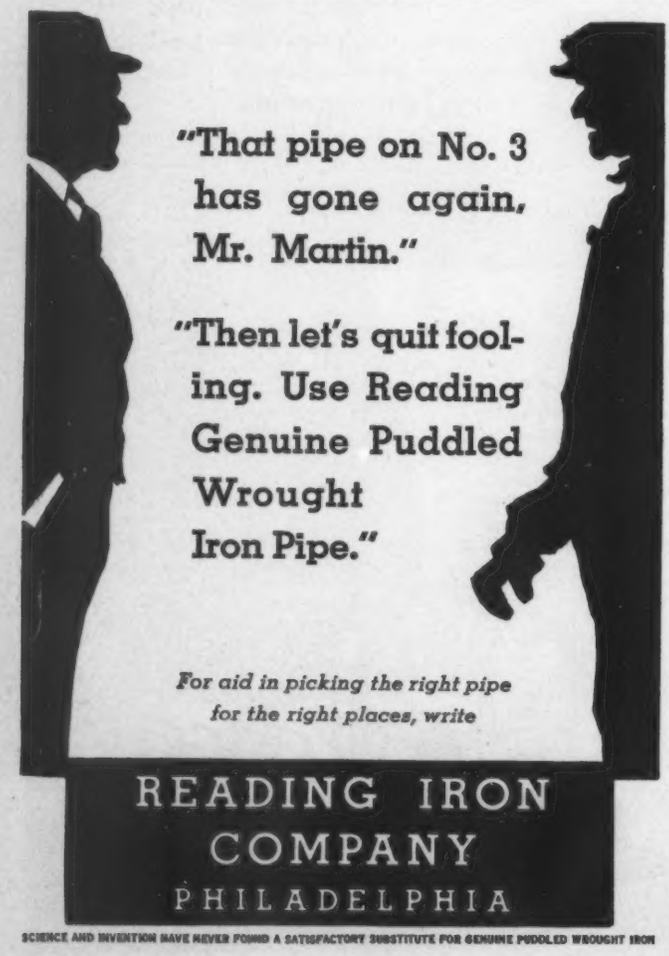
The decks, or bubble trays, inside the shell are built of one-half-inch plate. Each tray contains 36 risers and is supported on angles welded to the inside of the shell. The trays and supporting angles are welded with seven-thirty-second-inch electrodes.

Welding equipment used in building this tower was supplied by The Lincoln Electric Company, Cleveland, Ohio.

Marketing Agency Organized in Texas

A CENTRAL agency to market refined products turned out by independent refiners in East Texas has been created and subscribed to by 12 of the large plant owners with announced intentions of erecting their own tanker loading terminal on the Texas coast to go after export business should domestic marketing concerns fail to absorb their offerings.

The East Texas agency is to be


"That pipe on No. 3 has gone again, Mr. Martin."
"Then let's quit fooling. Use Reading Genuine Puddled Wrought Iron Pipe."
For aid in picking the right pipe for the right places, write
READING IRON COMPANY
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SCIENCE AND INVENTION HAVE NEVER FOUND A SATISFACTORY SUBSTITUTE FOR GENUINE PUDDLED WROUGHT IRON

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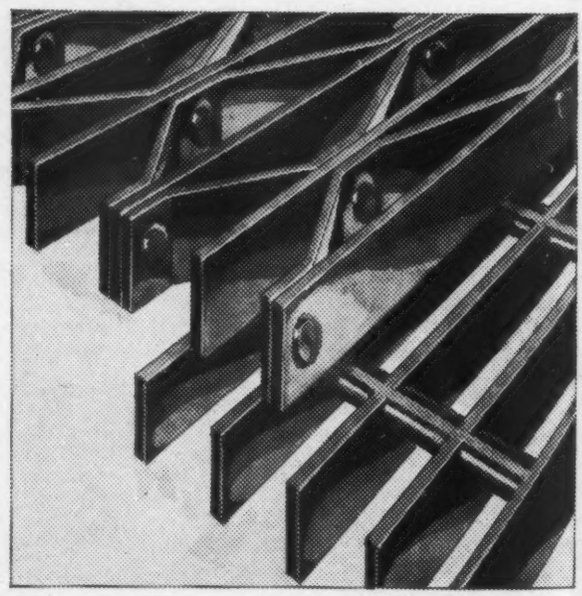

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known as the Independent Refiners Marketing Corporation, and has established an office at Kilgore. Neal Buckley, veteran export buyer for Cities Service Oil Company, Tulsa, has been engaged to assume charge of the concern. He spent the latter part of last week in New York City interviewing sales heads of a number of major oil companies considered prospective buyers of tender supported offerings by East Texas refiners.

An initial sum of $75,000 is reported raised by the members of the marketing pool to finance its operations.

The following East Texas refining units are credited with having joined the collective marketing plan: Arrow Refining & Producing Company, Chief Refining Company, Gilliland Refining Company, Lone Star Refining Company, La Pren Refining Company, Panama Refining Company, Southport Petroleum Company, Oil Refineries, Inc., Texas Oil Products Company, Trio Refining Company, Utah Refining Company and J. D. Wrather interests.

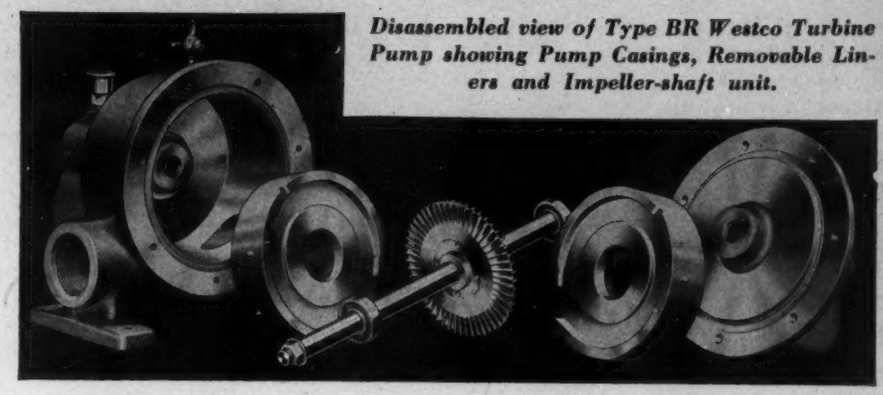
Establishment of an agency of this type has been contemplated for some months by East Texas refiners as a means of building up prices on refined products and to go after large contracts that have heretofore been beyond their reach.

Haslam Made Head Of Standard Sales

R. T. HASLAM, for several years connected with the development and sales operations of the Standard Oil Company of New Jersey has been appointed general manager of the domestic sales. In his new work Mr. Haslam will supervise sales of the Esso units which includes the domestic marketing operations of the Standard Oil Company of New Jersey, Standard Oil Company of Pennsylvania, Standard Oil Company of Louisiana and Colonial Beacon Oil Company. His appointment follows the resignation of R. G. Stewart, who resigned recently as vice president in charge of sales to engage in consulting work.

Houston Now Labor Consultant

BRYAN HOUSTON, member of the labor sub-committee of the Planning and Coordination Committee recently resigned his position as sales manager for Standard Oil Company of Ohio, to engage in labor consulting work, especially for oil companies. He has opened offices in the Hanna Building, Cleveland. A number of oil companies have already retained Mr. Hous-



Disassembled view of Type BR Westco Turbine Pump showing Pump Casings, Removable Liners and Impeller-shaft unit.

NEW PUMP IMPROVEMENT
saves money for WESTCO users

Patented, Removable Liners enable Westco to again lead the way in pump design

REMOVABLE LINERS are simply a complete lining for Westco Pump casings. They form the liquid channel and are quickly and easily removed from the casings. The money-saving advantages of this valuable feature are:

1. *Lifetime service from pump casings*
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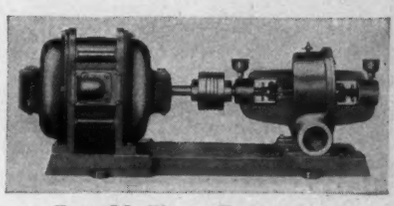
3. *"Stand-by" pump protection available at about 1/10 usual cost*
4. *Capacity of pump can be increased or decreased*

Superior Construction

Westco Turbine Pumps have a double-suction intake which creates a perfect hydraulic balance. Ingenious design of vertically split casing permits easy removal of Liners, Impeller-shaft unit and bearings (complete disassembly) without disturbing suction or discharge connections.

These pumps are favorites throughout the industry for Still Charging, and for handling Hot Oil, Fullers Earth, Chlorine Treating Solutions, Mineral Seal Oils, Naphtha, Chemicals, Brine, Water, etc.



Type BR Westco Turbine Pump

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HIGH PRESSURE — SINGLE STAGE

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ton as their representative. He has been handling labor and personnel for the past several years. He started in Magnolia Petroleum Company's service station department. Later he was manager of personnel for Tide Water Oil Company and for the past five years has been with Standard Oil Company of Ohio, engaged largely in personnel and labor work.

GEORGE BOWER, formerly with Humble Oil & Refining Company, is now superintendent of the Shoreline Oil Company's new refinery at Lewis, Louisiana.

DR. E. FRANKLIN ARMSTRONG, an executive of the Herbert Green & Co. Ltd. of England, recently organized to build a solvent refining plant, is in this country completing arrangements for plant construction.

GEO. F. ARNOLD, has been appointed superintendent of National Refining Company's Findlay, Ohio, refinery, to succeed the late Arthur J. Rogers. He has been with the company about 15 years, entering its service as an accountant, later being transferred to railway sales work, and still later to Findlay as office manager. He was promoted to assistant superintendent under Rogers, which position he held until the latter's death.

W. A. SLATER of the Port Arthur works, Gulf Refining Company, has been made general refinery manager for the company and is moving to the Pittsburgh headquarters. T. J. Sullivan and G. R. Roberts at Port Arthur, have been promoted to positions of assistant superintendent.

A. W. BREELAND, safety supervisor for the Lone Star Gas System, Dallas, Texas, has been appointed a member of the Texas State Committee of the Federal Training Program.

DR. V. HENNY, in charge of the London office of Universal Oil Products Company, is visiting the United States.

W. B. McCLURE, formerly administrator of the research projects under way in the Petroleum Refining Laboratory, Pennsylvania State College, has resigned to become assistant refinery manager for Kendall Refining Company, Bradford, Pennsylvania.

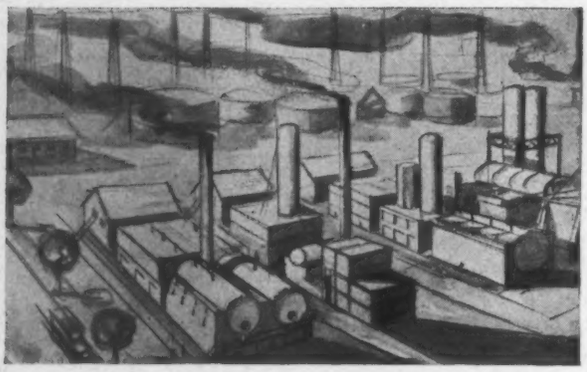
D. L. EDMONSON, former chief engineer, Sparton Refining Company, Shreveport, now is connected with Gilliland Refining Company, Gladewater, Texas, where he is associated with O. H. Berryman.

W. A. CAZORT, JR., formerly with H. H. Cross Company as chief chemist at the Smackover refinery, is now with Shoreline Oil Company at its Lewis, Louisiana, refinery in the dewaxing department.

J. H. CONE, chemical engineer, formerly with Humble Oil & Refining Company, has joined Shoreline Oil Company, at its new refinery at Lewis, Louisiana, as chief chemist.

N. B. PRICE, formerly with Humble Oil & Refining Company is now assistant superintendent for Shoreline Oil Company at its Lewis, Louisiana, refinery.

E. S. DICKEY has been appointed to the position of executive representative for American Meter Company, and will maintain his present address at the Maryland Meter Works office, 309 East Saratoga Street, Baltimore.



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Specially designed by Garlock for equipment handling gasoline and oils at extreme pressures and high temperatures, GARLOCK 7021 gives remarkably long service under severe conditions. Try it in *your* refinery!

THE GARLOCK PACKING COMPANY
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Tulsa, Okla. Houston, Texas Los Angeles, Cal.

W. S. ELLIOTT, president and founder of Elliott Company, died suddenly from a heart attack at his home late on the evening of February 21, 1935. He was 71 years old and was characteristically active to the last, having spent his last day working in the office at Pittsburgh. All his life he had been an indefatigable worker and his interest in the development of power plant engineering and the manufacturing of power plant equipment never lagged.

Mr. Elliott was born in Ohio, graduated from Cornell as a mechanical engineer in 1887, and at first embarked in the street railway business as an associate of Mr. Sprague, pioneer builder of the series traction motor for street railway service. He came to Pittsburgh in 1896 and started selling boilers for the Stirling Boiler Company. He was one of the first to realize the importance and the necessity of cleaning scale from the tubes of water tube boilers, and he immediately interested himself in the problem with the final result that in 1901 he incorporated Liberty Manufacturing Company in Pittsburgh to manufacture boiler tube cleaners. He later transferred the charter of Liberty Manufacturing Company to a new company known as Elliott Company and started to broaden his manufacturing interests with a line of

W. S. ELLIOTT

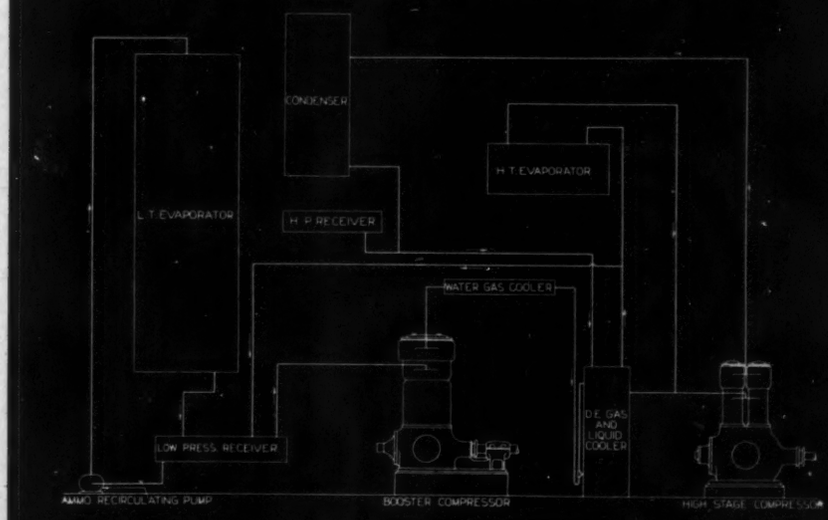
power plant accessories such as strainers, filters, blow-off valves, steam traps, etc.

In 1916 he took over The Lagonda Manufacturing Company, tube cleaner manufacturers in Springfield, Ohio, as a subsidiary company. In 1918 he started the manufacture of heat exchange equipment, including condensers and feed-water heaters. In 1923, through the purchase of the Kerr Turbine Company of Wellsville, New York, he entered the manufacture of steam turbines, and in 1926, he purchased Ridgway Dynamo and Engine Company of Ridgway, Pennsylvania, with its line of engines, generators, motors, blowers, and electrical machinery. This plant has been operated as the Ridgway Works, of Elliott Company, under the direction of his oldest son, G. F. Elliott.

Of the many definite contributions Mr. Elliott made to the art and development of power plant engineering, probably the outstanding example was his pioneering of the process of deaeration — removing dissolved air and gases from water to prevent corrosion. In 1924, the Franklin Institute awarded him The Edward Longstreth Medal for his "process and apparatus for the deaeration of liquids."

Mr. Elliott is survived by his widow, three sons, all of whom are in the Elliott Company, and a daughter, Mrs. Nohl of New York City. He was a

STUDY THIS DIAGRAM



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In the production of low pour test oils York Booster Compression and the York Patented Ammonia Liquid Recirculating System offer the following operating characteristics.

- Maximum flexibility and economy in compression plants with two temperature loads.
- Lower temperatures in the absorption plant which may be limited in that respect by existing water temperatures.
- Constant temperatures and pressures throughout the entire chilling surface . . . a feature exclusive with York.
- Absence of static pressure in chillers with the result that each stage operates at the highest ammonia pressure possible for the desired temperature.
- Satisfactory elimination of oil from booster discharge, avoiding contamination of absorption machine.
- Each square foot of evaporating surface is kept uniformly wetted with liquid ammonia and its efficiency is maintained by constant elimination of any oil carried over from compression side.

York Booster Compression and the York Patented Ammonia Liquid Recirculating System have accomplished savings of from 15 to 25% in horsepower with oil temperatures as low as minus 60 degrees F. It will pay to get the facts from the nearest of York's 71 direct factory branches. Bulletin 32164 is yours for the asking.

YORK ICE MACHINERY CORPORATION, YORK, PENNSYLVANIA

YORK REFRIGERATION

ABSORPTION & COMPRESSION

Efficient application for all types of solvent processing

member of the American Society of Mechanical Engineers, the Engineers Society of Western Pennsylvania, the Engineers Club of New York, and several Pittsburgh clubs.

HOWARD BENNETTE, president of Western Petroleum Refiners Association, died in Rochester, Minnesota, March 10. His health failed last fall due to excessive work as a member of the Planning and Coordination Committee and as co-ordinator of refining activities.

Bennette had been with the association since 1923 when he became secretary. Several years later he was elected president and held that post continuously afterward. With the drawing of the petroleum code he became active in affairs at Washington in connection with the industry and spent much of his time there until ill health compelled him to seek relief.

HOWARD BENNETTE

His connection with the petroleum industry was as a lawyer. Then he became secretary of the Texas Division of the Mid-Continent Oil & Gas Association with headquarters at Dallas. It was from this post that he went to the association of refiners and moved to Tulsa. He was born at Conroe, Texas.

His widow and one daughter, Miss Aubrey Pauling Bennette, are the immediate relatives.

Crude Oils from Fields Of Southern Louisiana

AS a part of a major study of crude oils produced in fields of the United States and throughout the world, the Bureau of Mines, Department of the Interior, has issued a report giving the analyses of 26 representative crude oils from various producing formations of southern Louisiana. These samples, including eight crude oils of naphthene base, eight crude oils of naphthene-intermediate base, and 10 crude oils of intermediate base, are from 14 fields in 10 parishes in the southern part of the state usually designated as the "Louisiana Gulf Coast Area."

This is the first published report of the Bureau of Mines in which the tabulated results showing the base of the crude oil have been extended to include seven classifications in place of the three so-called "bases" that have been found inadequate for differentiating all the known crude petroleum oils. The classification now used by the Bureau is as follows: Paraffin, paraffin-intermediate, intermediate-paraffin, intermediate, intermediate-naphthene, naphthene-intermediate, and naphthene. These names indicate the differentiation in characteristics of the oils through the range from paraffin to naphthene base. Only one of the intervening classifications, namely, naphthene-intermediate is represented in the samples reported. The results of the analyses of southern Louisiana crude oils show that the crude oils of each district have the same general characteristics, the crude oils of each field vary in specific characteristics from the oils of other southern Louisiana fields, and the stratigraphic position of the producing bed has a decided influence on the characteristics of the oil.

Tables present the summary of properties of the oils; summary of data indicating the base of the crude oils; a comparison of the crude oils of intermediate base; of naphthene-intermediate base; and of intermediate base produced in the different fields; and a summary history of the fields. In addition, an individual distillation analysis by the Bureau of Mines Hempel method is given for each of the 26 samples.

Samples were obtained from the Darrow and Sorrento fields, Ascension Parish; the Gueydan field, Vermilion Parish; the Iowa, Lockport, and Sulphur fields, Calcasieu Parish; the Jennings field, Acadia Parish; the Lake Barre and Lake Pelto fields, Terrebonne Parish; the Leesville field, La Fourche Parish; the Port Barre field, St. Landry Parish; and the Sweet Lake, Welsh, and White Castle fields in the parishes of Cameron, Jefferson Davis, and Iberville, respectively.

Copies of R. I. 3253, "Analyses of Crude Oils from some Fields of southern Louisiana", by A. J. Kraemer and E. L. Garton, may be obtained without cost upon request to the Information Division, Bureau of Mines, Washington, D. C.

New Fire Protection Data Published

AN errata sheet correcting and bringing up to date the manual, "Fire Protection in Refineries," published in its first edition in 1934, has been prepared by the American Petroleum Institute.

Corrections are made in text or tables appearing on several pages.

Correction

AN error has been noted in the printing of I. N. Beall's article appearing on page 77 of the February issue of The Refiner under the title, "Some Thermodynamic Data of Application to the Light Saturated Hydrocarbons." The first equation present in the article and appearing in the first paragraph, last column, page 77 should read as follows:

The external heat of vaporization may then be calculated from the vapor pressure data and specific volumes by the formula.

$$1 = \frac{144\,(V_s - V_l)P}{778.3}$$

Where P = vapor pressure in lbs. sq. in. abs.

Correction

IN the article "Practical Considerations for Refinery Pump Selection" appearing on page 53 of the February issue of The Refiner, attention is called to an error appearing on page 55. Under "The disadvantages of piston type pumps," No. 2, the sentence should read "Should not be selected to pump liquid containing suspended abrasive materials." On page 59, under the heading "Centrifugal pumps" and under the enumerated advantages, in No. 5 a line was dropped, and the sentence should read as follows: "The centrifugal volute pump at the present stage of pump development is the best pump available for pumping oils which contain abrasive materials."

Correction

IN the article, "The Efficiency of Petroleum Fractionating Columns," Part 1, by V. W. Garton and R. L. Huntington, appearing on page 18 of the January issue of The Refiner an error in printing of the legends under four curves appearing on page 20 has been noted. Figure 5 refers to distillation of benzine-toluene mixture at 5 cc. per minute, Figure 6 at 3 cc. Figure 7 at 1 cc. and Figure 8 at 2 cc. per minute.

PLANT ACTIVITIES

Cracking: United Refining Company, Warren, Pennsylvania, has signed license contract with Universal Oil Products Company and will remodel its cracking unit to adapt it to Dubbs full flashing operation. A flash chamber, bubble tower, and hot oil pump are to be added, making possible gas oil cracking as well as reforming. Capacity about 400 barrels daily.

Merger: Wayco Refining Company, Detroit and Toledo and certain of the A. J. Youmans interests in producing oil and gas properties in Central Michigan have been merged, giving the refining division permanent crude sources.

Booster Station: Great Lakes Pipe Line Company is adding a Rannett type booster unit between Ponca City and Barnsdall, Oklahoma. The location is Section 22, Township 25n, Range 6a, five miles northeast of Fairfax, Oklahoma. Unit consists of a centrifugal pump driven by a 400 horsepower electric motor, and controls.

Operating: McClanahan Oil Refining Company, St. Louis, Michigan, has started operating its 1500-barrel skimming plant, recently completed under supervision of E. G. Guy. D. E. Foster is operating superintendent.

Unit Operating: Mid-Continent Petroleum Corporation, West Tulsa, has placed in operation its new 3600-barrel pressed distillate atmospheric Foster Wheeler redistillation unit, replacing battery of 20 shell stills.

Gasoline Plant: Sabine Valley Gasoline Company, H. R. Dickerson, Shreveport, president, is building an 11-unit natural gasoline plant, north of Kilgore, Texas, on the Mary Scott survey, Gregg County, East Texas field. Capacity 30,000 gallons, taking gas from about 900 wells. Estimated cost $550,000. Engineering work by Petroleum Engineering Company associated with Arthur G. McKee Company.

Gasoline Plant: Royalite Oil Company (Imperial Oil Company, Ltd.), will build a second natural gasoline plant in the Turner Valley, Alberta, Canada, field. Announced location, north end of Section 33-18-25w, on the old Sterling-Pacific lease. Maturity, spring of 1935.

Sale: Altitude Petroleum Corporation has announced its 5000-barrel Chanute, Kansas, refinery for sale, following a year's idleness. Plant was lately modernized and includes cracking facilities.

Refinery: "Nitag", at Petroleumhafen, Germany, announces construction of an 8000-barrel combination topping and cracking unit, Winkler-Koch Engineering Company type and to include a unit of the Lachman treating process. J. C. Bradley, L. S. Wright and Cash Brisby sailed from New York late in February to have charge of construction.

Enlarge: Pioneer Oil & Refining Company, Somerset, Texas, is enlarging its lubricating oil plant.

Improvements: Associated Oil Company, Los Angeles, in its recent announcement of $8,900,000 expenditures for 1935, included statement that $575,000 would be spent for manufacturing equipment and improvements at the Watson and Avon refineries.

Tanks: Gulf Refining Company, Port Arthur, Texas, has let contract to Petroleum Iron Works, Beaumont, for 205 tons of steel plate to be fabricated into 14 pressure tanks.

Tanks: Ashland Refining Company, Catlettsburgh, Kentucky, has let contract to Chicago Bridge & Iron Works for construction of three asphalt tanks, requiring 175 tons of steel plate.

Cracking: Wilshire Oil Company, Los Angeles, has signed contract with Universal Oil Products Company for a 12,000-barrel combination skimming and Dubbs cracking unit. To operate on full flashing principle. Location, Santa Fe Springs, adjacent to the company's operating natural gasoline plant and tank farm.

Dismantled: Waggoner Refining Company, Electra, Texas, has purchased the 2500-barrel skimming and cracking plant of Iowa Park Producing & Refining Company, and is dismantling the skimming equipment.

Dismantled: Dale Oil & Refining Company, Electra, Texas, has sold its 5000-barrel skimming plant to Kimball & Bostic Supply Company, which is dismantling the equipment.

Gasoline Plant: Casingas Corporation, Camden, Arkansas, has started construction on a natural gasoline plant in the Kilgore Section of the East Texas field, located on the Willis Smith tract, J. S. Caruthers Survey, Gregg County. Fred W. Bowen, P. O. Box 997 Kilgore, Texas, in charge of construction.

Improvements: Skelly Oil Company at its Eldorado, Kansas, refinery is improving plant through addition of two new fractionation columns.

Improvement: Kanotex Refining Company, Arkansas City, Kansas, is rearranging crude oil distillation facilities to secure pressure distillation operation in revamped Jenkins cracking equipment.

Stabilizer: Dickey Refining Company, McPherson, Kansas, is adding a new debutanizing column to the vapor recovery plant for the stabilization of a light blending fraction.

Recovery Plant: H. F. Wilcox Oil & Gas Company, Bristow, Oklahoma, is erecting a modern vapor recovery and stabilization system. Contract to Burrell-Mase Engineering Company.

Improvements: Shoreline Oil Company, Lewis, Louisiana, (mail address Vivian, Louisiana), has added improvements to its 1750-barrel lubricating oil plant consisting of a Sharples centrifugal dewaxing plant and acid treating system.

Carbon Black—United Carbon Company, subsidiary of the United States Rubber Company, is erecting a channel type carbon black plant near Sanford, Hutchinson County, Texas Panhandle district, with a daily capacity of 50,000,000 cubic feet of gas. This plant will process residue gas from The F. C. Henderson Company's 150,000,000 cubic foot daily capacity well pressure natural gasoline extraction unit, which is operating at two-thirds capacity.

Gasoline Plant—Gregg-Tex Gasoline Corporation, Longview, Texas, plans to enlarge the capacity of its natural gasoline manufacturing plant in the Longview section of the East Texas field through the addition of two units, making a total of eight. The company has been processing casinghead gas from about 900 prorated wells, and has contracted for the output of about 400 additional wells.

SCIENCE AND TECHNOLOGY

Abstracts prepared in co-operation with the

REFINER AND NATURAL GASOLINE MANUFACTURER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstract, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

Phase Equilibria in Hydrocarbon Systems. VI. B. H. SAGE, W. N. LACEY, AND J. G. SCHAAFSMA. *Ind. Eng. Chem.* **27** (1935), pp. 48-50.

The authors determine the thermodynamic properties of normal pentane up to pressures of 3000 lbs. per square inch absolute and at temperatures from 70 to 220°F. Previous work of other investigators is briefly reviewed. The specific gravity of normal pentane in the condensed liquid region was measured as a function of pressure at a series of temperatures. The specific heat at constant pressure for liquid pentane under a total pressure of 1000 lbs. per square inch absolute was determined as a function of temperature by the adiabatic expansion method. The ratio of fugacity to pressure, as a function of pressure, was calculated for a series of temperatures. Also the specific heat content and specific entropy for condensed and saturated liquid pentane have been calculated. Corresponding calculations were made for the saturated gas, using Young's data combined with data of the authors. A temperature entropy diagram is presented that is believed to be very accurate in the condensed liquid region, accurate to within about 1.5% in the two phase region, and to within 5% in the superheated gas region.

Specific Heat of Liquid Pure Hydrocarbons and Petroleum Fractions. L. P. GAUCHER. *Ind. Eng. Chem.* **27** (1935), pp. 57-64.

Data on the specific heats of hydrocarbons and of petroleum fractions were reviewed to determine if they could be correlated in such manner as to develop a relationship more accurate than those currently used. An empirical equation involving both specific gravity and boiling points was developed that correlates available data on the pure hydrocarbons with an average deviation of 1.3 and a maximum deviation of 6%. Although the relationship has no fundamental basis, it is an improvement over existent correlations. An effort was made to improve upon the available correlations of the data on petroleum fractions, but this was unsuccessful and further study is required. Deviations of all of the more recent of these data from the correlations of Watson and Nelson, Fortsch and Whitman, and of Cragoe are submitted. The Watson and Nelson correlation is regarded as most satisfactory. The relationships between the A.S.T.M. 50% point and gravity for straight run and cracked fractions are discussed in relationship to the preparation of a plot that will enable the use of the Watson and Nelson correlation with fair accuracy when actual boiling point data are not available. A bibliography of 74 references on specific heat is appended.

Molecular Weight of Cracked Distillates. O. FITZSIMONS AND E. W. THIELE. *Ind. Eng. Chem., Anal. Ed.* **7** (1935), pp. 11-14.

The authors note the importance of molecular weights in connection with the design of refinery equipment, and comment on the desirability of some means of estimating molecular weights from some properties more easily determined. The present work is devoted to an extension of previous work on straight-run stock, to cracked stock, all made from Mid-Continent gas oil; a few Mid-Continent pressure still charging stocks are included. The apparatus used for molecular weight determinations is described. The cryoscopic method was used with some novel changes. Charts are given for A.P.I. gravity versus molecular weight, for normal paraffin Mid-Continent straight-run and Mid-Continent cracked stock, for molecular weight versus the 50% A.S.T.M. boiling point, and for molecular weight versus kinematic viscosity.

Viscosity of Petroleum Products. W. B. MCCLUER AND M. R. FENSKE. *Ind. Eng. Chem.* **27** (1935), pp. 82-86.

The authors have studied the conversion of viscosity as expressed in Saybolt seconds to kinematic viscosity. The design of absolute viscometers is discussed and a justification for the type of absolute viscometer used by the authors presented. Two calibrated Saybolt viscometers were used. The viscosity of 100 oils was measured in each two absolute viscometers and the two Saybolt Universal viscometers. The oils used were from various sources and represent a wide variety of crude types. The temperature-viscosity coefficient for water was determined as 0.6833 for the viscosity at 37.78°C. compared to that at 20°C. Accurate knowledge of this ratio is important because without it, it is impossible to obtain accurate viscosity values at various temperatures, since water is invariably used as the standard or reference fluid. The data secured are presented in tabular and also in graphical form. It is concluded that the conversion of viscosities cannot be represented by any simple single relation.

High-Molecular Normal Paraffin Hydrocarbons. L. IVANOVSKY. *Petroleum, Zeitschrift, etc.* **30**, No. 42 (1934), p. 1. *Brennstoff-Chemie* **15**, (1934), p. 473.

The values of the physical properties of the high-molecular weight paraffins, such as melting point, density, refractive index, and molecular volume, were studied in relation to molecular weight. Curves were derived applying to the normal paraffins containing 20-40 carbon atoms. There was no linear relationship between melting point, refractive index, and density, and molecular weight. However, refractive index and density bear a linear relationship to melting point. These relationships are given by the following equation:

$N_D^{90} = 0.0004 +$ melting point in °C. $+ 1.4010$

$d_4^{90} = 0.0008 +$ melting point in °C. $+ 0.7120$

Mol. vol.$^{90} = 17.6 +$ C atoms $+ 37.5$

Heats of Organic Reactions. I. The Apparatus and Heat of Hydrogenation of Ethylene. G. B. KISTIAKOWSKY, H. ROMEYN, J. R. RUHOFF, H. A. SMITH, AND W. E. VAUGHAN. *Jour. Am. Chem. Soc.* **57** (1935), pp. 65-75.

A calorimeter is described that permits the measurement of the heat of catalytic hydrogenation and other gas phase reactions at temperatures not above 150°F. with a precision of the order of one tenth of 1%. The heat of hydrogenation of ethylene was determined at 82°C. as $H = 32{,}824 \pm 50$ calories. Using available heat capacity data, the values of the heat of hydrogenation were calculated for the temperatures 25°C. and 0°C. A sensitive quantitative method for detecting small amounts of ethylene in saturated hydrocarbon-hydrogen mixtures is described. A still head for fractionating columns designed to operate at constant pressure with partial return of reflux while distilling low-boiling compounds is also described.

Chemical Composition and Reactions

The Decomposition of Aliphatic and Alicyclic Hydrocarbons by Aluminum Chloride. K. H. BAUER AND V. TOMA. *Berichte der deutschen chemischen Gesellschaft* **67** (1934), p. 1135.

When octadecane was heated with 25% by weight of anhydrous aluminum chloride, reaction

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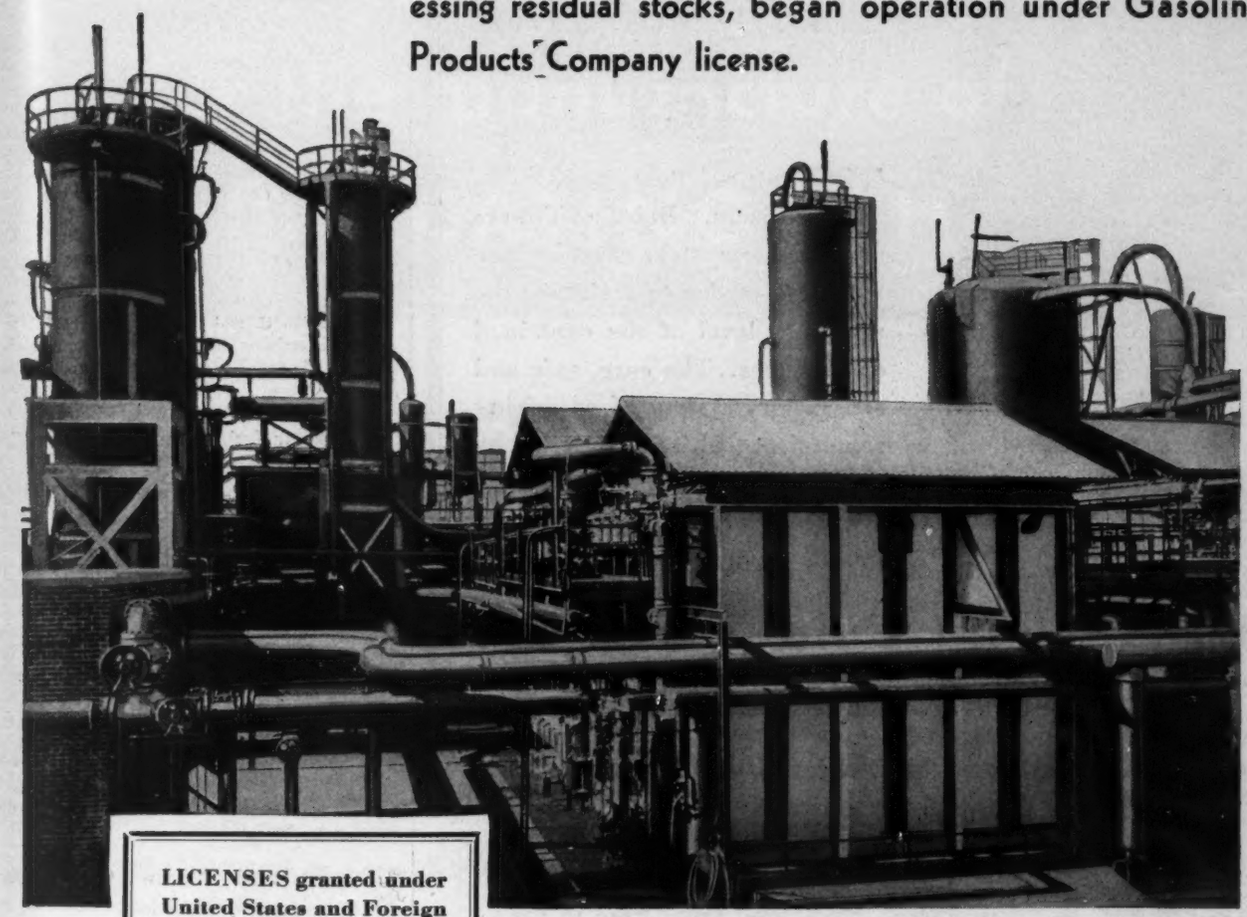

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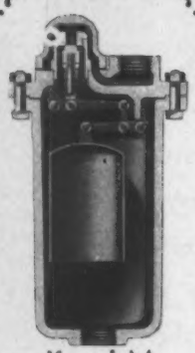

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started at 110°C. Seven fractions were collected. None reacted with sulfuric acid or iodine. Approximately 60% of liquid products were secured boiling in the range 20° to 220°C. Thirteen percent of uncondensable gas was formed; the balance was carbon or condensation products. Hexatriacontane under similar conditions reacted vigorously at 150°C. with evolution of gas. Octahydroanthracene similarly treated began to react at 205°C. and yielded 52% of liquid condensate, of which only the highest fraction had an iodine number. It was judged that naphthene hydrocarbons were present in these distillates because the specific gravity and refractive index were higher than for the products derived from octadecane and hexatriacontane. Gas from the two high molecular weight paraffin hydrocarbons contained 85% of hydrocarbon substances, whereas that from octahydroanthracene contained 43.6% hydrocarbons and 54% hydrogen. The octadecane used was prepared from octadecyl bromide and magnesium bromide, melted at 28°C. and boiled at 181-182°C. at 15 mm. Hexatriacontane was made from octadecyl iodide and metallic sodium. Its melting point was 76°C.

Synthetic Lubricating Oils from Condensation Products of Ethylene. H. SCHILDWACHTER. *Angew. Chem.* **47** (1934), pp. 677-81.

Lubricating oils of high quality can be secured in good yield by condensing ethylene with coal-tar products. The viscosity of these oils can be increased further, if desired, by electrical treatment. The oils are stable at high temperature, free from asphalt, and do not readily form asphaltic substances. They show a high resistance to oxidation. Addition of volatilized fatty oils improves the temperature-viscosity relationship. The making of oils from ethylene and naphthalene, tetralin, and coal-tar oil and tar distillates is described. Yields range from 4% to 33%. The tar distillate of boiling point 165-290°C. gave the best result.

Synthesis of Benzene from Carbon Monoxide and Hydrogen Under Atmospheric Pressure. S. TSUNEOKA AND K. FUJIMURA (in German). *J. Soc. Chem. Japan*, **37** (8), (1934), pp. 463B-467B.

Experiments are described in which benzene was synthesized from carbon monoxide and hydrogen under atmospheric pressure. It was found that excess of carbon monoxide had no bad influence on the synthesis, but that excess of hydrogen favored the formation of methane. The catalyst used was a specially prepared one consisting of nickel, together with 15% manganese, 3% thorium dioxide, and 125% Kieselguhr. An electrically heated aluminum oven was used.

Manufacture:

Processes and Plant

Data on Heat Transfer and Pressure Drop for an Oil in a Copper Tube. J. F. DOWNIE SMITH. *Trans. Am. Inst. Chem. Engrs.*, Nov. 1934 (preprint) 28 pp.

Film coefficients of heat transfer and friction factors were measured both for heating and cooling of oil in a horizontal tube 10 feet 2½ inches long and 0.822 inches inside diameter, at velocities covering the ranges of turbulent and viscous flow. For turbulent flow $(hd/k) / (cZ/k)^n_M$ can be plotted against the mean Reynolds' number. For heating the value of the exponent n is 0.4, and for cooling 0.3. This treatment did not prove to be satisfactory for viscous flow, although good curves were obtained for the value $n = 0.21$. Using $(t_1 - t_2) / (t_1 - T_1)$ and hd/k as ordinates, and Wc/kl as

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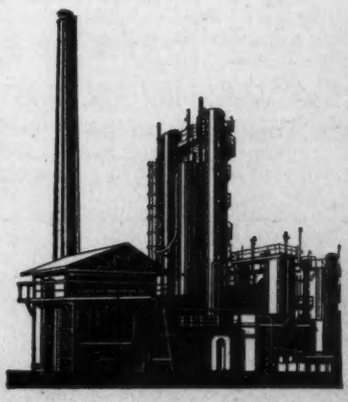

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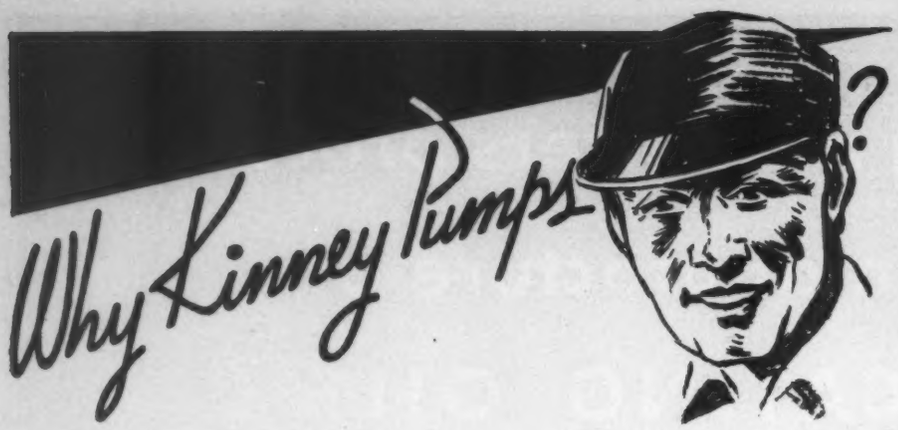

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absiccas, the data secured agree in order of magnitude with the data of others. In the region of turbulent flow the effect of heat transfer on fluid friction was found to be similar to that observed by others. However, in the region of viscous flow, the effect of heat transfer on friction differed from anything previously noted, at least in the heating runs. This was attributed to the large rise in temperature of the oil in its passage through the tube. Prandtl's equation combining heat transfer and fluid friction is in rough agreement with the data secured in the tests. When the friction factor is plotted against the Reynolds' number in the viscous range, the resulting plot does not coincide with the isothermal flow curve.

Efficiency of Rectification and Appropriate Path for Liquid Flow. E. KIRSCHBAUM. *Forsch. Gebiete Ingenieurw.* B5 (1934), pp. 245-54.

The author shows that the vapor from the trays in a fractionating column may have a higher content of the lower-boiling component than would be indicated from the equilibrium diagram for the liquid on the tray. The extent of this deviation has been determined. It is stated that plate efficiency may run over 100%, and an explanation for this is given. The liquid path over the plate that should be used to secure this effect is described.

Stable Organic Compounds in Power Generation. D. H. KILLEFFER. *Ind. Eng. Chem.*, 27 (1935), pp. 10-15.

The author describes the recently built boiler plant of the Dow Chemical Company, in which Dowtherm or a mixture of diphenol and diphenol oxide is used for the indirect superheating and for the reheating of steam in a boiler generating steam at 1400 lbs. pressure. The advantages of the procedure are discussed and data, diagrams and photographs are given.

Products:

Properties and Utilization

Inhibitors in Cracked Gasoline, III. C. G. DRYER, J. C. MORRELL, S. EGLOFF, AND C. D. LOWRY, JR. *Ind. Eng. Chem.* 27 (1935), pp. 15-20.

Five typical cracked gasolines were studied. These included two from Pennsylvania, one untreated and one treated with Fuller's earth in the vapor phase; two from the Mid-Continent, one untreated and one treated with three pounds of 93% sulfuric acid; and one reformed gasoline from West Texas, untreated. These were stored in glass bottles vented to the air for 20 months. Inhibitors were added to some samples. For any one gasoline a relationship was found between the induction period as determined in steel bombs at 100°C. and 100 pounds oxygen pressure, and storage life. An induction period of 300 minutes, or an increase in initial induction of 200 minutes, obtained by the addition of an inhibitor, produced a storage life of over one year in small containers in all but one instance, namely that of the untreated Mid-Continent gasoline which, although it had an induction period of 245 minutes, deteriorated in five months, forming both peroxide and gum. The stability of the samples in storage was found to be related, with few exceptions, to the critical oxidation potentials of the inhibitors present when the inhibiting substances are added in equimolar concentration. Cracked gasoline changes slowly at first when stored, forming a small amount of gum (air-jet) and a low concentration of peroxide. After a period, the formation of peroxides and gum increases suddenly and is accompanied by a sharp rise in copper dish gum, darkening in color, and loss of octane

rating. The formation of 10 milligrams of air-jet gum usually denotes that the period of slow change is nearly over, and 15 milligrams marks the beginning of rapid change. The data are presented in tabular form and a bibliography of 18 references is appended.

Use of Mixtures of Gasoline with Ethyl and Isopropyl Alcohols in Internal-Combustion Engines. M. S. KUHRING. *Can. J. Research* **11** (1934), p. 489.

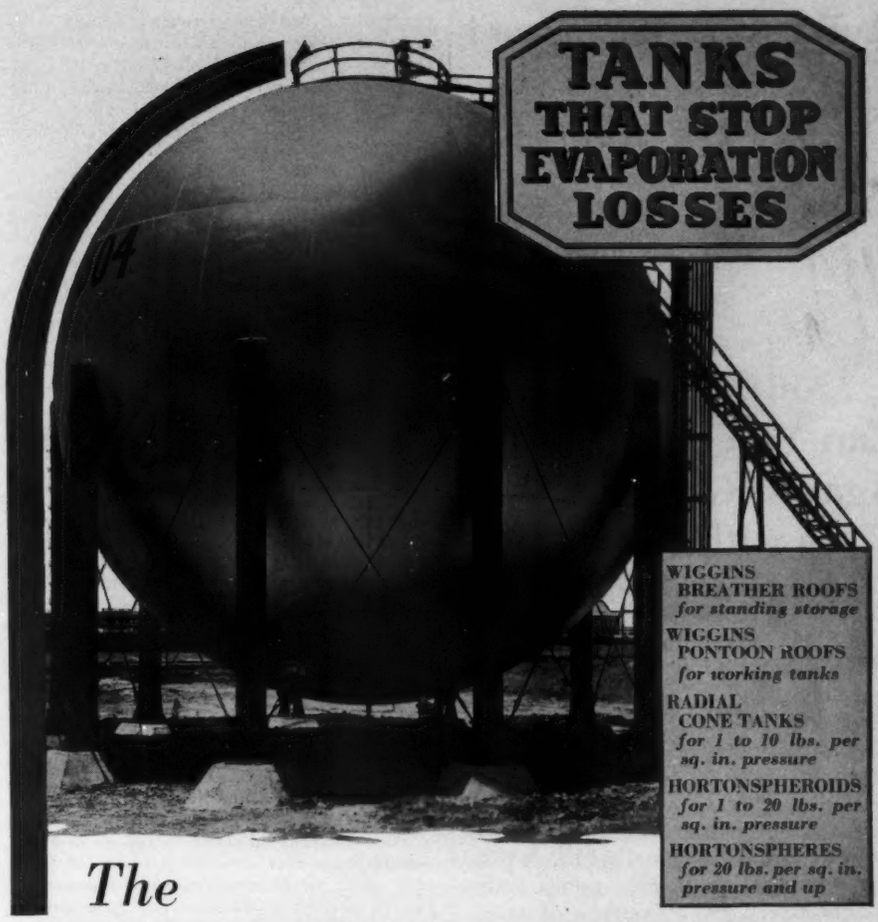
Tests were conducted on gasoline and various mixtures of gasoline with isopropyl and ethyl alcohol. Tetraethyl lead was also added to some of the fuel mixtures. Data secured in tests included octane number, power, fuel consumption, and the H.U.C.R. It was concluded that once detonation is suppressed, no further increase in power is to be expected with increase in antiknock value, unless compression ratio is raised. Ethyl alcohol-gasoline fuel mixtures showed higher fuel consumption than gasoline alone, provided the gasoline is straight-run or cracked casinghead gasoline without tetraethyl lead. Alcohol-gasoline mixtures were found to be less susceptible to tetraethyl lead than the gasoline without alcohol. In fuels containing 10% of alcohol, fuel consumption was higher when ethyl alcohol was used than when isopropyl alcohol was used. This was also true of the 20% alcohol solution. However, with 30% alcohol solutions the specific fuel consumption was higher for those made with isopropyl alcohol than those made with ethyl alcohol. Ethyl alcohol is superior as a knock inhibitor, but when the highest useful compression ratio was determined the 10% and 20% solutions of isopropyl alcohol were found to be superior to those of similar ethyl alcohol concentration. However, above 20% alcohol, the ethyl alcohol is more effective in reducing knocking than isopropyl alcohol.

The Mean Specific Fuel Consumption of Different Motor Fuels. WAWRZINIOK. *Automobiltech. Z.* **37** (1934), pp. 21-5, 47-51, 74-7.

The author studied binary and ternary mixtures of gasoline, benzene and absolute alcohol. Comparative fuel consumptions were determined. It was proved that the addition of proper amounts of alcohol to gasoline or to gasoline-benzene mixtures is advantageous. The addition of benzene, and to a greater extent the addition of alcohol, increased the knock resistance of the gasoline-air mixtures. Up to a concentration of 15% of alcohol by weight, the mean specific fuel consumption of the gasoline-alcohol mixtures was the same as that of gasoline alone. Above 15% it was somewhat higher. The addition of benzene to gasoline reduces the specific fuel consumption up to the richest mixtures used, which were 50:50. The consumption of gasoline-benzene-alcohol mixtures is higher than that of gasoline-benzene, but not as high as that of gasoline alone. The slight increase in fuel consumption occasioned by the addition of alcohol is compensated by an increase in the efficiency of the engine, particularly at low speed where gasoline alone caused knocking. The specific fuel consumption was markedly influenced by the type of engine used. None of the engines had a high compression ratio; they were all suitable for use with gasoline alone.

Notes and Observations on Gasoline and Diesel Engines. H. R. RICARDO. *J. Inst. Automobile Engrs.* (London) **1**, No. 6, pp. 13-30; No. 8 (1933), pp. 45-70.

The author reaches the conclusion that the greater part of the loss of metal from the cylinder liners of an engine is accounted for by direct corrosion caused by products of partial



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The Hortonsphere stops evaporation loss from light oil products by permitting an internal pressure to be built up, instead of venting vapor out into the air.

Boiling

Boiling occurs in open tanks when the vapor pressure of the liquid exceeds atmospheric pressure. In a closed container, the vapor pressure built up by rising temperature is opposed by an equal gas pressure in the space above the liquid surface. Therefore, no boiling of a volatile product can occur in a Hortonsphere as long as the vapor pressure of the liquid does not exceed the absolute pressure for which the relief valve is set, that is, atmospheric pressure plus gauge pressure.

Breathing

The Hortonsphere obviously stops breathing losses because air is not drawn in and forced out through the valves daily except in rare cases when the pressure exceeds the setting of the relief valve.

Filling

It also stops most of the filling losses—after the first filling—for vapor forms as the Hortonsphere is emptied and condenses as it is filled, tending to keep the pressure constant.

The Hortonsphere is the most economical type of container for liquids which require pressures of 20 lbs. per sq. in. or greater. Our nearest office will be glad to send you estimates on this or any other type of tanks without obligation to you.

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Birmingham.....1548 Fiftieth Street, N.	Boston.....1529 Consolidated Gas Bldg.
Chicago.....2463 Old Colony Bldg.	San Francisco.....1051 Rialto Bldg.
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. . . Neither Can You Win Against Gasoline Fires with the Wrong Extinguisher!

WITH LUX you have an extinguisher that is "right" for more than one kind of refinery and bulk plant fire. LUX puts out oil or gasoline spill fires as quickly as any other hand extinguisher. It puts out fires in oil running from a leaking pipe or overflowing tank truck against which other extinguishers usually fail. It puts out fires in live electric pump room motors safely. No other type of extinguisher is effective against all three.

Who knows what his next fire will be? The wise oil man investigates the triple protection of the LUX extinguisher. Write Walter Kidde & Company, Inc., Bloomfield, N. J.

HERE IS AN EXTINGUISHER THAT PUTS OUT THREE DIFFERENT KINDS OF OIL FIRES— NOT JUST ONE
LUX
Triple Fire Protection for
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combustion. Two independently operating cylinders were used, one of which had a combustion chamber designed in such manner that the products of partial combustion were largely suppressed. The other was a normal cylinder. The iron oxide found in the lubricating oil of the first cylinder was only a fraction of that found in the oil in the crankcase serving the normal cylinder. Furthermore, in the first instance the iron oxide found was practically constant and independent of the load, whereas in the latter it increased rapidly with load and as the flame reached further toward the cold cylinder walls. The author comments on the fact that surface hardness is an unimportant factor in relation to wear, and that this is not inconsistent with the theory that corrosion is the principal cause of wear.

Fuel and Oil Economy for the Operator. J. C. GENIESSE. *S. A. E. Jour.* **36**, No. 1 (1935), p. 22.

Maximum thermal efficiency for a gasoline engine is found at an air:fuel ratio of approximately 16:1, and the highest mean effective pressure or torque at about 12.5:1. The best economy is to be secured at about 14.1:1. A richer mixture should be supplied for driving in hilly country than in flat country. For driving with wide-open throttle a 13.5:1 mixture should be supplied to give high torque and good acceleration. For idling a very rich mixture is necessary because of poor manifold distribution. For high speed driving at part throttle, a leaner mixture, such as 16:1, is best adapted, but the mixture should be enriched for high speed driving in rolling country. The records of a bus company operating in and about Philadelphia show that at a temperature of 22°F. 18% more gasoline is consumed than under summer driving conditions. This is caused by poor distribution, use of the choke, and idling at terminal points. The use of S.A.E.-60 oil increased fuel consumption 6.4%, as against the use of S.A.E.-30 oil. S.A.E.-30 oil required 3% more gasoline than 10-W oil. The more volatile gasolines, such as aviation gasoline, with lower energy content, counterbalance this factor by better distribution to the cylinders.

Some Factors Influencing Gasoline and Oil Consumption. HENRY S. DEBBLINK. *S. A. E. Jour.* **36**, No. 1 (1935), p. 20.

The maintenance cost of the Milwaukee Electric Railway and Light Company's gasoline-vehicle fleet of 213 automobiles and 184 buses has trended downward during the last 10 years on account of improvement in the vehicles and in maintenance methods. It was concluded that the gasoline consumption does not depend upon the age of the vehicles if these are reasonably well maintained, but is largely influenced by corburetion, float-level, operation of choke, and freedom from leaks in the gasoline system. Consumption increases rapidly with the number of starts and stops, and also depends on loads carried. It is affected by average daily mileage and by temperature and weather conditions. Fast schedules increase consumption. Highly volatile gasolines affect consumption adversely. Oil consumption is decreased by using the minimum practical clearance between pistons and cylinder walls. Oil-return rings should have high capacity, and piston oil holes and passages for oil return should be ample. Crankcase-oil temperatures should be low.

Gasoline and Kerosene Poisoning in Children. JOHN A. NUNN AND F. M. MARTIN. *J. Am. Med. Assoc.* **103** (1934), pp. 472-4.

The results of inhalation of gasoline are more serious than those caused by ingestion. Treatment consists of gastric lavage or emesis and the use of laxatives. For the artificial stimulation of respiration the use of 95% oxygen and 5% carbon dioxide mixture is recommended.

Interim Report of the Research and Standardization Committee on Cylinder Wear. C. G. WILLIAMS. *J. Inst. Automobile Engrs.* (London) **1**, No. 8 (1933), pp. 73-92.

Accelerated cylinder wear was not caused by dilution of the cylinder oil with gasoline, even up to 90%, unless the oil was contaminated with abrasive material. Delayed warming up causes a marked increase in cylinder wear, and this, together with delay in supplying oil to the walls of the cylinders, provides the worst possible combination of circumstances. Increase in wear at low temperatures is related to the condensation of water from the products of combustion, and may also be caused by the presence in the water of organic acids, sulfuric and nitric acids, and dissolved carbon dioxide.

Lubrication as Affected by Physical Properties of Lubricants. R. C. WILLIAMS. *Ind. Eng. Chem.* **27** (1935), pp. 64-66.

The author studied lubrication as related to the process of drawing wire and the utility of various solid lubricants in connection with this process. Among the materials studied were light and heavy mineral oils, oleic acid, stearic acid, paraffin wax, beeswax, halowax, aroclor, and petroleum asphalt. It was concluded (1) that the lubricant must adhere strongly to at least one of the surfaces, either to the wire or to the die; (2) that the lubricant must be solid prior to being subjected to the relative shearing of the surfaces to be lubricated; and (3) that the lubricant must melt or be transformed to a fairly mobile liquid between the surfaces while the shearing takes place. The coefficient of friction largely depends upon the viscosity and thickness of the film of lubricant, rather than on the chemical nature of the lubricant or of the surfaces. Beeswax gave the lowest coefficient of friction and the paraffin wax next lowest.

Industrial Lubrication and Lubricants. O. L. MAAG. *Can. Mining J.* **55** (1934), pp. 495-7.

The author describes greases made from oils of various types, from light-bodied nonviscous oils to heavy cylinder stocks, in admixture with calcium soap, sodium soap, aluminum stearate, and lead soap. The use of extreme-pressure greases is being increased. Aluminum stearate greases ordinarily recover their original consistency even if they have been heated well above their melting point. Circulating oil systems are discussed in relation to mine-car and high-speed lubrication.

The Utilization of Petroleum Products as Horticultural Spray Materials. H. MARTIN. *Jour. Inst. Tech.* **20** (1934), pp. 1070-89.

The employment of petroleum oils for winter washes for application to deciduous crops in the dormant season and as summer washes applied to deciduous trees and herbaceous plants is discussed. The result of critical laboratory and field trials leads to the conclusion that the ovicidal and insecticidal properties of petroleum

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oil sprays applied to dormant trees are independent of the base of the oil, of its viscosity within the range 126 to 870 seconds Redwood at 70°F. and of its degree of refinement as indicated by the range of unsulphonated residues from 60 to 100% by volume. Petroleum oils suitable for application to foliage are limited to the highly refined oils of viscosity high enough to insure satisfactory insecticidal properties. The evidence indicates that the insecticidal properties of oil sprays applied to foliage decrease as the stability of the emulsifier increases. The selection of suitable emulsifiers is discussed. Naphthenic acids are shown to be unsatisfactory soap substitutes. Sulphonic acids produced during acid treatment include the gamma acids, of which the calcium salts are water soluble and which are promising spray materials, and the beta acids with insoluble calcium salts but oil soluble sodium salts and acids which are of possible use as emulsifiers.

Routine High-Vacuum Distillation of Oils. K. M. WATSON AND C. WIRTH, III. *Ind. Eng. Chem., Anal. Ed.* **7** (1935), pp. 72-5.

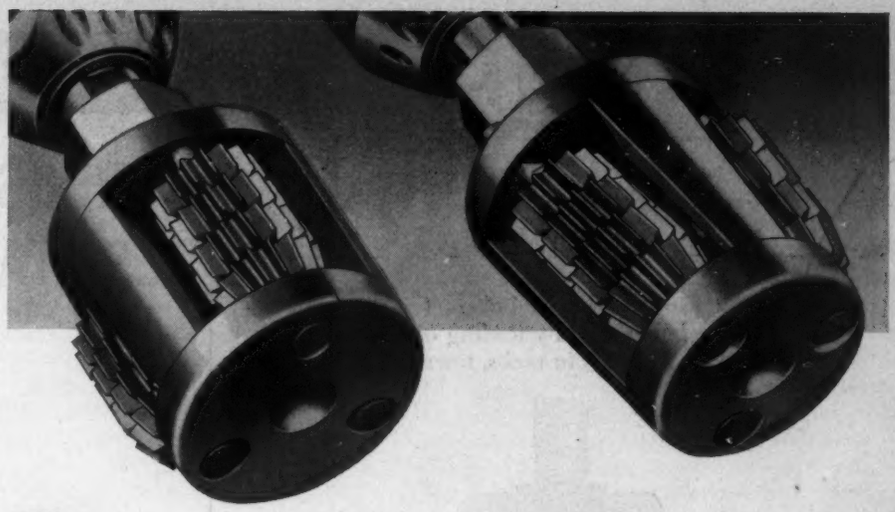
The authors comment on the fact that a generally standardized method for evaluating the boiling points of heavy oils is badly needed. Not only are measurements of boiling points themselves important, but it is well known that most of the difficultly measurable physical properties of petroleum fractions are better correlated on the basis of boiling point than any other easily determined property. The apparatus described was developed to permit operation at pressures of approximately 0.1 mm. of mercury. It has the advantage of satisfactory accuracy in pressure measurement on account of the elimination of condensible vapors in the McLeod gage. Ground glass connections are extensively employed, which allows a minimum of difficulty in the distillation and cleaning. A chart is given for the conversion of boiling points at low pressures to boiling points at higher pressures. The time required for a complete vacuum distillation, including assembling and cleaning the apparatus, ranges from 75 to 90 minutes.

Apparatus for the Control of Pressure in Distillation. G. W. JACOBS. *Ind. Eng. Chem., Anal. Ed.,* **7** (1935), pp. 70-1.

The author comments on the fact that much work has been done on the subject of controlling pressure in laboratory apparatus. Reference is made to articles and bibliographies on this subject. The present paper describes a simplified and improved form of valve, the parts of which can be easily duplicated. The basis of the apparatus is an electro-magnetically operated flutter valve, operating against a capillary leak. The writer considers the sulfuric acid manostat a great improvement over the ordinary differential monometer employing mercury. The apparatus has been in use at Rutgers University since July, 1933, and has proved extremely satisfactory. It is capable of smooth regulation in pressure to within $\pm$ 0.015 mm.

Estimation of Unsaturation in Aliphatic Hydrocarbons by Bromide-Bromate Titration. S. P. MULLIKEN AND R. L. WAKEMAN. *Ind. Eng. Chem., Anal. Ed.,* **7** (1935), p. 59.

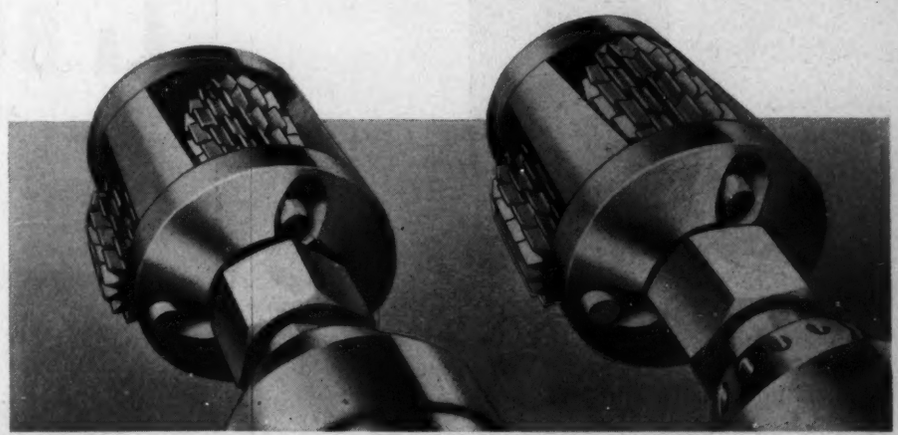
The authors tested the bromide-bromate titration as a method for the estimation of unsaturation in hydrocarbons. They conclude that this titration can be used with a fair degree of accuracy for the titration of most alkenes and also for the determination of the number of double bonds present in cycloalkenes and in alkadienes. Its application under ordinary conditions in the presence of atmospheric oxygen to alkines and to cycloalkadienes, such as the terpenes, is of doubtful value.



For more effective still tube cleaning

LIBERTY Types J-21 and J-31 CUTTER HEADS

These two new cutter heads are designed to team up with modern high-speed, high-powered tube cleaner motors. They are extremely rugged and simple, and may be taken apart in a moment for cutter replacement. These heads have very pronounced self-feed, working themselves into the coke and greatly speeding up the cleaning.
The J-21 head is designed for heavy coke, and the J-31 for light coke conditions, the difference being in the taper of the spider and the angle of throw of cutter pins. To obtain maximum results, it is important to use the head suited to the coke condition encountered.
These heads, driven by Liberty "OS" motors, are the formula for efficient speedy still tube cleaning. For details write for the bulletin.



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JERGUSON

REFLEX GAGES

have been used for steam boilers for 25 years and are now being used by leading oil companies for indicating oil levels in tanks, towers, stills, etc.

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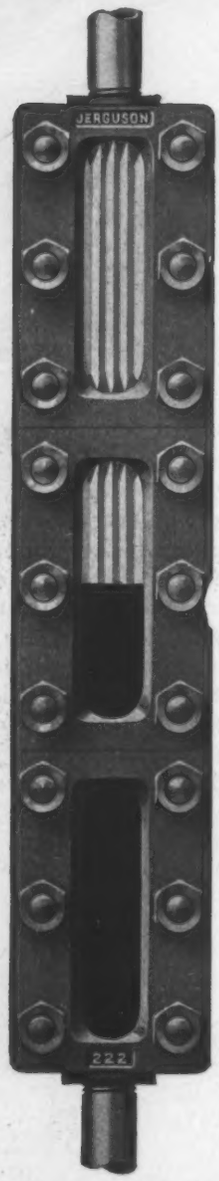

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They are safe and durable at the highest pressures and temperatures. We can furnish gages with or without valves for every type of service. Full information upon request.

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PUMPING ACID?

CORROSION RESISTANCE IS ONLY HALF THE PROBLEM

WHEN SULPHURIC or other acids are to be moved, it is not enough merely to secure a pump which will withstand the corrosive effects of the liquid. The effectiveness of the pump, from the standpoint of operating costs, and the features of its design making for long, trouble-free service, should be considered quite as carefully as the material from which it is made. LaBour Pumps, both priming and non-priming, have been serving the process field dependably and economically for so many years that there can be no question as to their value. We shall be glad to supply details about the application of LaBour Pumps to your particular conditions. There is no cost or obligation involved when you ask us about them.

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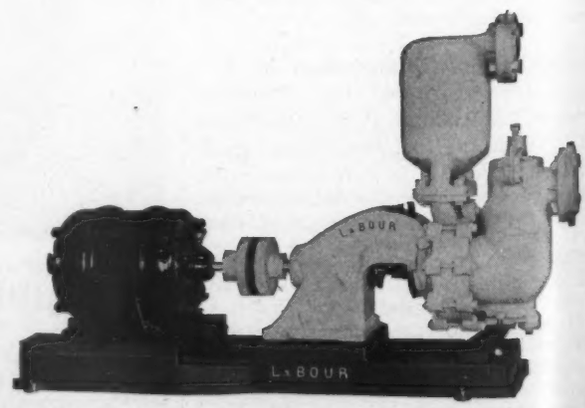
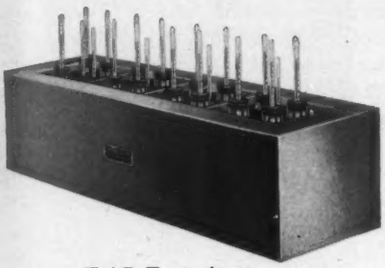


New Equipment for the Modern Plant

Test Apparatus

C. J. TAGLIABUE MFG. COMPANY

C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, New York, has designed a



TAG Test Apparatus

four compartment "cold test" apparatus to meet the latest A.S.T.M. Cloud and Pour Test specifications (serial D 97-34) for lubricating oils. These specifications require at least three and preferably four, cold test baths at the following temperatures:

1—Temperature +30 to +35°F.
2—Temperature 0 to + 5°F.
3—Temperature —30 to —25°F.
4—Temperature —60 to —55°F.

The compartments of this newly designed TAG Apparatus are copper-lined and well insulated with two-inch cork on sides and bottom making them separate cooling units. In each compartment there is an assembly of four metal jackets, mounted on a substantial metal tripod, for supporting the cold test jars and thermometers in accordance with A.S.T.M. specifications. This is the same assembly which has been used for many years in the TAG Single Unit Cloud and Pour Test apparatus.

Vapor Tension Test Gauge

THE FOXBORO COMPANY

The Foxboro Company, Foxboro, Massachusetts, announces a new design of vapor tension test gauge for which interesting and unusual features are claimed by the manufacturer. The company has endeavored to attain the high degree of accuracy so necessary when determining true vapor pressure.

The calibration of each dial to its individual spring has enabled The Foxboro Company to guarantee that these gauges will have an accuracy of one half of one percent of the total scale at any point.

To insure continuously accurate readings in a gauge of this type, it is necessary at times to make some adjustment to compensate for changes in atmospheric temperature and other upsetting conditions. This is accomplished in the new gauge by an adjustable dial. Two screws placed in slots hold the dial in place. To reset the zero point simply loosen the two screws, turn the dial to the correct position and tighten the screws. The operation takes only a few seconds. This method of recalibration removes all danger of injuring delicate parts of the gauge since the slotted dial makes it unnecessary to touch the pointer at all.

To further insure accuracy, the gauge is equipped with a movement that is light yet durable. The Bourdon spring and all moveable parts are made of bronze, heavily cadmium plated for protection against moisture, corroding fumes and

Foxboro Tension Test Gauge

vapors. An Everdur hair spring guarantees further protection.

The gauge is mounted in a buffed brass case. The glass is held in the ring by a heavy vellumoid gasket secured by a retaining ring. A second gasket inside the connection makes the gauge completely water-proof. A square, rust-proof steel connection simplifies mounting and dismounting from the bomb and protects the gauge from frequent twisting strains.

Packing

THE PACKING ENGINEERING CORPORATION

The Packing Engineering Corporation, Cranford, N. J., has perfected a new square section non-metallic plastic coil packing for acid work. Tests are said to have proven a high degree of efficiency for this packing, which is designated as ACE-O-PAX No. 4X.

Gate Valve

READING-PRATT & CADY COMPANY

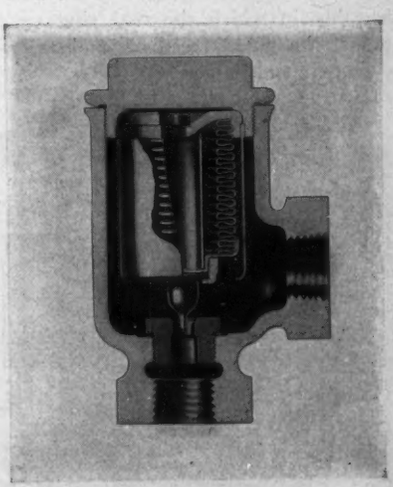
Reading-Pratt & Cady Company, Bridgeport, Connecticut, has added a new type clip gate valve to its extensive line of valves. The new valve has a round bonnet and differs essentially from the conventional style of clip gate valves. This type of bonnet construction permits the use of a male and female joint with asbestos gasket that assures tightness.

A full U-bolt is used to hold the bonnet joint tight. When the nuts on these bolts are tightened, pressure is equalized on both sides, a difficult operation with independent bolt styles. Among the internal features are the full thickness I-beam cast wedge which brings sturdiness to the valve seat and permits the use of full size body guides to assure correct seating.

Steam Trap

SARCO COMPANY

Sarco Company, 183 Madison Avenue, New York, has announced the Sarco thermostatic steam trap No. 9-200, designed for steady or fluctuating pressures from 0 to 200 pounds. It is especially designed for draining high pressure steam coils and jackets in connection with industrial heating and process work as well as for removing condensate from steam supply lines to all types of equipment. The trap is said to require no adjustment in the field when steam pressures change. The thermostatic bellows is made from Sarco helically corrugated tube of heavy wall. Special caps are used for the top and bottom of the bellows which have internal screw threads of the same pitch and profile as the flexible tubing, which is screwed right into the



Sarco Steam Trap

cap. This makes a strong mechanical joint which is made pressure tight by sealing with special high temperature solder. The shield protects the element over its entire length against the abrasive action of steam and also permits the element to be removed from the trap body while hot, if this is desired. The body and cap are heavy cast bronze. A raised face metal-to-metal joint is used between cap and body. No gasket is needed. The valve head is spherical for high capacity and moveably mounted to assure perfect seating. Valve head and seat are of stainless steel for long life and absence of scoring. Both are easily renewable.

Threading Machine

LANDIS MACHINE COMPANY

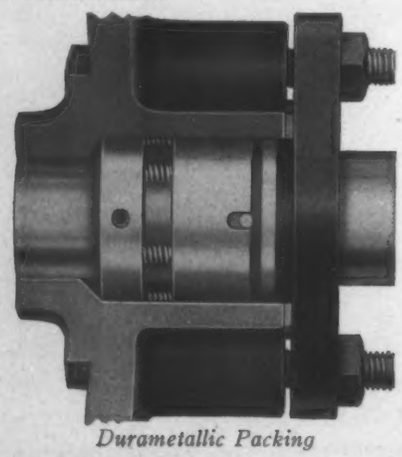
Landis Machine Company, Waynesboro, Pennsylvania, is offering a new type combination pipe and bolt threading machine for general maintenance work. The machine is of the lathe type, in which the work is revolved, and is designed to thread, ream, and cut off pipe, and thread bolts and rods. It is made in the motor-driven type only, employing a one horsepower motor and control of industrial type.

Packing

DURAMETALLIC CORPORATION

Durametallic Corporation, Kalamazoo, Michigan, has announced a new type of mechanical seal, or packing, which will be called "Dura Seal." It was developed for use on such power equipment as pumps and exhausters that handle gritty or corrosive liquids and gases. It is especially recommended for handling acids, alkalies and dirty liquids containing solids. It can be applied to ordinary stuffing boxes.

On higher pressures an assembly in which the member rotating with the shaft is placed entirely within the stuffing box, and revolves against the faced off gland or special stationary bushing should be used. On moderate pressures an outside assembly in which the seal ring rotates against the gland faced off and reversed is recommended.



Durametallic Packing

Air Nozzles

THE LUNKENHEIMER COMPANY

The Lunkenheimer Company, Cincinnati, Ohio, has placed on the market two new designs of bronze air nozzles with renewable, non-metallic discs. One is made with integral hose end, and the other with female pipe end. Either pattern can be furnished with pointed, flat, or extension tip.

Figure 1840-PT

Figure 1841-PT

These air nozzles find wide application for blowing dust, dirt, chips, filings, borings, sand, lint, liquid deposits and other matter, and quickly pay for their initial cost in savings of time and labor, and prevention of air wastage. They are more effective and safer to use than brushes, rags and hand bellows.

The disc is especially compounded for air service, and easy renewability insures seat tightness. To renew a disc, simply unscrew the nut at bottom of nozzle and remove spring and old disc; insert a new disc and reassemble.

Unrestricted flow area permits free passage through the nozzle of scale and grit that might be carried with the air from the pipe line.

Provision is made for hanging the air nozzle on a nail or small hook when not in use.

Plastic Material

THE B. F. GOODRICH COMPANY

The B. F. Goodrich Company, Akron, Ohio, announce a new plastic material, said to be superior to rubber for the manufacture of a wide variety of products. The material, perfected after extensive experiments, may be molded into any shape, may be produced in colors, is odorless, resisting the action of various chemicals injurious to rubber, and possesses even greater flexing life than rubber, according to Goodrich engineers. The new product is known as Koroseal. It is resistant to oil and greases and to disintegration in the presence of corrosive chemicals. One of its uses is for oil sealing gaskets and packing. Although it is not the same as rubber in chemical composition it may, like rubber, be varied by compounding methods from very hard to soft, doughy consistency. It is expected to replace rubber in general use but will be applied in some instances where rubbery consistency, combined with superior resistance to certain oils and chemicals and where flexing is required.

Valve Service Chart

MERCO NORDSTROM VALVE CO.

Merco Nordstrom Valve Company, Pittsburgh, Pa., a subsidiary of Pittsburgh Equitable Meter Company, has recently issued a service chart describing under the headings, "Operation", "Adjustment," "Lubrication" and "Repair", the proper care for Nordstrom lubricated plug valves. The service chart is printed on heavy stock, suitable for tacking on the wall in operating headquarters or near valve installations.

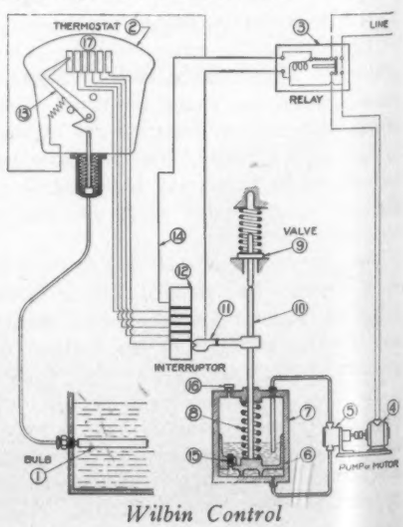
Control

WILBIN INSTRUMENT CORPORATION

Wilbin Instrument Corporation, 40 East 34th St., New York, announces development of a new system of temperature control. It consists of an electric thermostat of the liquid expansion type, and equipped with commutator switch carrying six separate contacts.

This thermostat operates a valve actuator. The latter consists of a piston moved up and down in a cylinder by oil pressure generated by a motor driven pump. The motor is started and stopped by the thermostat in such a way that the valve adjusts itself to a throttling position between open and closed just sufficiently to maintain the desired temperature.

The instrument is suitable for temperatures from minus 50°F. to plus 950°F., and can be used with valves suitable for steam, water, oil, gas, or brine. Both the sensitivity of the thermostat and the speed of valve travel are adjustable by the user so that the control can be synchronized accurately with the heat cycle.

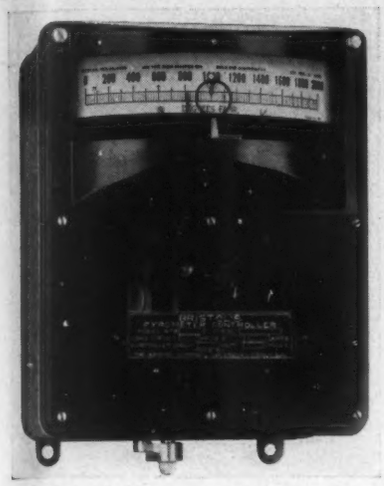


Wilbin Control

Temperature Control

THE BRISTOL COMPANY

The Bristol Company, Waterbury, Conn., announces a new pyrometer controller which is said to possess "degree-splitting" characteristics that permit an unflinching check over any heating process.



Bristol Temperature Control

Model 478 has several outstanding features: (a) clean, non-arching, non-oxidizing, non-corroding mercury-to-mercury electric contacts, sealed in glass; (b) no need for relays; (c) operating mechanism always visible; (d) accessibility of telechron motor, mercury switches and terminal block, simplifying field inspection without exposing control mechanism to dirt, fumes, or misalignment; (d) full safety features; (e) accurate control; (f) simple and rugged working parts.

Centrifugal Pump

WORTHINGTON PUMP & MACHINERY CORPORATION

Worthington Pump & Machinery Corporation, of Harrison, New Jersey, announces an advancement development of its two-stage Monobloc pump. The low power requirements and simplicity of this modern unit make it especially applicable to all services requiring small capacity and medium discharge head. The casing, designed to withstand 150 pounds pressure, is bolted directly to the motor frame without an intermediate distance piece, thus eliminating the necessity for a baseplate.

Attention is particularly drawn to the unique impeller design, which is a unit construction consisting of two enclosed type impellers cast back-to-back, so that the overhung weight is actually no greater than that on a single stage pump. The impeller, which is keyed, is held firmly to the shaft by an impeller nut and the shaft sleeve, also keyed, is a separate, renewable part.

Reliability is attained through the use of a motor which features oversize grease lubricated ball bearings. In this Monobloc unit, the impeller is mounted directly on the motor shaft, eliminating additional space and weight of a coupling.

This unit can be mounted vertically or horizontally, with full assurance of satisfactory performance in either case.

Advanced features of design, adopted with a view of combining high efficiency and dependability, appear in these new models. The pump has steep head capacity characteristics and is designed for air conditioning installations, refrigeration service, boiler return and chemical process work.

Compressor

GARDNER-DENVER COMPANY

Gardner-Denver Company, Quincy, Illinois, has announced a new six cylinder, water-cooled, two-stage compressor which the manufacturer states has a number of unusual features of design. These features provide more delivered air, with a resultant saving in power cost.

An outstanding departure from conventional compressor design is the use of four small diameter low pressure cylinders, instead of two large ones, this construction permitting the use of small, light weight pistons and considerably reducing the in-

Books on Petroleum and Refining

HEAT TRANSMISSION—*William H. McAdams.*

A comprehensive treatise sponsored by the Committee on Heat Transmission, National Research Council, dealing with the various fields of heat transmission, based on considerable unpublished data as well as on a critical examination of the literature. Contains authoritative correlations for the various important cases of heat transfer with 33 examples of the application of the recommended relations. Published January, 1933. Price, $5.00.

CHEMISTRY AND TECHNOLOGY OF CRACKING—*A. N. Sachanen and M. D. Tilicheyev.*

Published in December, 1932, this book is a valuable addition to the library of those interested in cracking unit design, construction, or operation, or in the general subject of the chemistry of cracking. This late work covers thoroughly the fundamental features of cracking, chemistry of cracking, chemical composition of cracked products, properties and chemical treatment, the principle cracking systems, and includes an excellent chapter on the hydrogenation of petroleum products.

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BUTANE-PROPANE GASES HANDBOOK, Volume 2—Arranged and Edited by *Geo. H. Finley, Editor, Western Gas.*

The second edition of the Butane-Propane Gases Handbook, published February, 1935, is the only work of its kind and presents a most thorough treatment of the liquefied petroleum gases industry. Contents: Summary of Developments, Use in Internal Combustion Engines, Design and Installation of Storage, Supply from Petroleum Refineries, Engineering Data on the Lower Olefins, Domestic Appliance Testing and Utilization, Competitive Position of the Liquefied Gases, Town Plants, Manufacture from Natural Gas, and Special Uses. Supplements and revisions include, Transportation, Use with Other Gases, Analysis and Testing, Properties of Mixtures, Distribution, Bibliography, Central Plant Directory, Catalog Section and Buyers Guide.

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THE SCIENTIFIC PRINCIPLES OF PETROLEUM TECHNOLOGY—*Dr. Leo Gurwitsch and Harold Moore, 1932 revised edition.*

The original translation of Gurwitsch's second edition (1925) appeared in 1926, and in response to a wide appeal the preparation of a second edition was undertaken by Harold Moore and C. I. Kelly, to include data on technical and scientific work on petroleum to 1932. The well known standard reference work is the most comprehensive treatment of petroleum technology now available.

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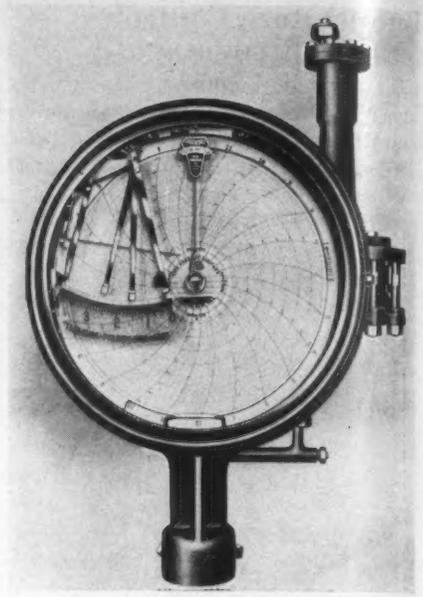
ertia loads. Use of two pairs of low pressure water cooled cylinders provides lower air temperatures than previously obtained in small vertical compressors, with corresponding saving in horsepower.

By water cooling the cylinder walls, lower wall temperatures are obtained, with better lubrication and longer life. Distortion of cylinder walls from heat is eliminated, and the compressor operates independently of atmospheric temperatures. Mountings include motor mounted on shaft; V-belt to electric motor, Diesel or gasoline engines; or direct connected through flexible flywheel coupling to motor and engines.

Meter

THE FOXBORO COMPANY

The Foxboro Company, Foxboro, Mass., has announced a universal meter designed to measure any fluid under any industrial condition. It is claimed that this meter meets requirements for demands of conditions such as a simple recording meter, or a pressure compensating or correlated temperature, pressure and flow records. The instrument has a flow rangeability of ten to one, giving the rangeability advantages of two separate meters. The charts have uniform graduations to secure



Foxboro Meter

easy readings. Where necessary, it is said, temperature and pressure records may be recorded on the same chart with the flow. When a multiple-pen recorder is furnished, all pens move about the same center of rotation and do not interfere with each other at any point in their travel.

A mechanical integrator has been built specially for this meter, which shows the total flow on an easily read counter, which reads directly in terms of total flow. A recording pen can be added which makes a mark on the chart rim when the integrator adds a given amount to its count.

A pressure compensator is provided wherever widely varying static pressures are present which corrects both the record and the integrator reading for all variations in static pressure and the action is said to be instantaneous, automatic and continuous.

The meter is protected from over-range flows or incorrect manifold valve manipulation by Foxboro check valves, which are float type and positive in operation. In addition, the meter can be furnished with a transparent indicating scale that makes it possible for the flow to be read at a glance. The meter is for measuring steam, oil, air, water, gas, acids or other fluid under any industrial condition.

Power Pump

WORTHINGTON PUMP & MACH. CORPORATION

Worthington Pump and Machinery Corporation, Harrison, New Jersey, has announced completion of an 18-inch stroke totally-enclosed horizontal duplex power pump for a variety of uses. The power end is self-sustained, is supported on the foundation throughout

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its length, and is designed to minimize the cost of foundations.

The totally-enclosed power end was developed primarily for refinery service, but since the moving parts are fully protected from dust and dirt, it has a wide field of usefulness in field and pipe line service loads up to 200 horsepower.

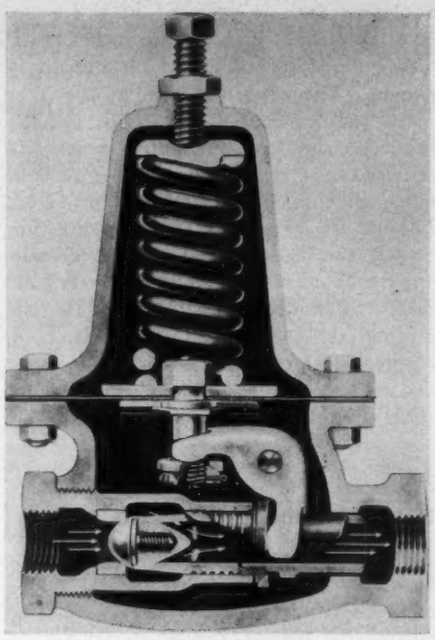
Pressure Reducing Valve

A. W. CASH COMPANY

A. W. Cash Company, Decatur, Illinois, has announced a streamlined pressure reducing valve in various trims and for all fluids, which shows a revolutionary departure from conventional valve design, the manufacturer claims.

Following airplane design, the valve proper has a blunt nose and a trailing edge, so that no matter how high the velocity, the trailing edge pulls no vacuum to retard flow. The purpose of this scientifically streamlined contour is to insure maximum capacity. The conventional dividing wall is dispensed with and from inlet to outlet, the fluid flows through this valve in a straight line—a streamline. There is no turbulence or hindrance to maximum flow.

A jet extends into the outlet chamber. When demand increases an accelerated flow through this jet produces



Cash Pressure Reducing Valve

an aspirating effect that lowers the pressure in the control chamber (below diaphragm) and thus opens the valve wide to meet peak demand. When the diaphragm moves in a closing direction, the valve proper must close because it is tied to the diaphragm by means of the cam lever.

Track-Type Limit Switch

GENERAL ELECTRIC COMPANY

General Electric Company, Schenectady, New York, has introduced a small, track-type, spring-return limit switch, intended for use in making or breaking control or indicating circuits at a fixed point in the travel of a part of a machine or mechanism. The switch, designated as CR9440-A1A, has one normally open and one normally closed circuit. Its maximum carrying and breaking capacity is 5 amperes at 550 volts a.c. and on d.c. ranges upward from 0.4 amperes at 550 volts to 2.0 amperes at 115 volts.

The new device is operated by an 18 degree movement of its operating arm from the normal position, an overtravel of 54 degrees being possible without causing damage to the switch. A precision mechanism on the operating arm affords simple, accurate adjustment of the arm to any position around the operating shaft. This mechanism consists of a worm-and-gear arrangement in which the threads on the bolt that clamps the arm to the shaft engage with threads on the latter. Double-break silver-plated contacts, opening and closing with a sliding motion, assures good electrical connections.

The switch, with the exception of its

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operating arm, is enclosed in a die-cast box four inches high, 2 7/16 inches wide, and 1 29/32 inches deep. Installation is simple. The operating arm moves in a plane parallel to the base of the switch; hence no right-angle mounting bracket is required. At the bottom of the case, a half-inch conduit connection is provided. Because of its spring-return feature, the switch can be mounted at any desired angle without affecting operation. A ball-protected oil hole at the front of the operating shaft simplifies lubrication. A removable aluminum cover provides convenient access to contacts and wiring studs. Contacts are easily renewable.

Meter

RALPH N. BRODIE COMPANY

Ralph N. Brodie Company, 973 61st St., Oakland, California, announces development of Model X-500 meter, which increases the line of Brodie meters to the point where capacity range is from two

Brodie Meter

to 1000 gallons per minute. It is a positive displacement meter of the valveless type with rated capacity of 600 gallons per minute. Flow diagrams, dimensions and other data are available.

Portable Potentiometer

THE BROWN INSTRUMENT CO.

The Brown Instrument Company, Philadelphia, announces a new Portable Potentiometer designed to enable pyrometer users to check their potentiometers, millivoltmeters and thermocouples quickly and accurately.

The combination of a step-switch and slide wire makes it possible to read the indicating scale to 0.01 millivolts over a total range of 71 millivolts. This step-switch and slide wire combination is equivalent to having a slide wire 109 inches long. The indicating scale is 17 inches long, making the smallest scale division (0.05 mv) over 1/16 of an inch in width.

Brown Potentiometer

A fully enclosed, suspension type galvanometer is used. Having a very short period (approximately two seconds) readings can be taken rapidly, as the galvanometer responds immediately when dial is moved to a new position. Two sets of binding posts and a toggle switch, provided for thermocouple checking, further facilitate taking check readings quickly and accurately.

The potentiometer circuit has been designed primarily for checking pyrometers and thermocouples. In addition, this portable potentiometer can be used as a measured source of E.M.F. in checking recording potentiometers of the self-balancing type. The circuit draws only three milliamperes from the dry cell, giving the dry cell a life of several months and permitting the instrument to be used for several hours on one standardization of the battery current.

In addition to being simple in construction and accurate, this potentiometer is small in size and light in weight. It is 9⅜ wide by 10¼ deep by 6¾ inches high, and weighs only 12¾ pounds.

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CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Control Devices

Chaplin Fulton Manufacturing Company, Pittsburgh, is distributing an enlarged 1935 catalog which is dedicated to those responsible for the safe and economical distribution and regulation of natural and manufactured gas, and for the controlling of the steam pressure and gas fuel supply to steam boilers. The catalog is well printed, illustrated, and provided with charts and tables. The types of regulators described and shown cover all the more common forms of service for both natural and manufactured gas, and the availability of special regulators for many special purposes in the use of steam, water, oil and air is made plain.

Photo-Electric Cells

Continental Electric Company, St. Charles, Illinois, has issued an interesting bulletin concerning photo electric cells and their various applications.

This bulletin will be mailed without charge upon request.

Forgings

Kropp Forge Company, Chicago, recently issued a new bulletin, "Forging the Impossible", which will be of interest to many individuals and companies. The bulletin describes and illustrates some of the difficult forgings made by the company.

Motor Brushes

The Ohio Carbon Company, 12508 Berea Road, Lakewood, Ohio, has prepared a booklet, "The Brush Phase of Motor Maintenance," which deals in practical, non-mathematical terms with the causes and effects of sparking, excessive wear, etc., of brushes, commutators and slip-rings on direct current motors and generators.

Welding

General Electric Company, Schenectady, New York, has issued two new bulletins which are incidental to welding. Bulletins No. GEA-1440C describes the company's improved arc welders, while Bulletin No. GEA-1546B describes and lists welding electrodes and accessories manufactured by the company.

Draft Gauges

The Hays Corporation, Michigan City, Indiana, has issued Bulletin No. 2018, covering the company's line of "Draftrol" electric contact gages for indicating and controlling draft, pressure and differential draft or pressure.

Centrifugal Pumps

Worthington Pump and Machinery Corporation, Harrison, N. J., has published Bulletin W-312-B3A, which describes the single-stage volute Type L centrifugal pumps is manufactures.

Forged Steel Products

Kerotest Manufacturing Company, Pittsburgh, manufacturers of oil field valves and fittings for oil field service, recently has issued a new 12-page bulletin describing its line of forged steel flange unions, crosses, tees, elbows, gauge valves and control chokes. Copies of this new informative bulletin will be gladly sent on request.

Gears

Palmer-Bee Company, Detroit, Michigan, has issued Section 104 of its general catalog No. 100 which lists the company's complete line of speed reducers and general gearing.

Insulation

Harbison-Walker Refractories Company, 1800 Farmers Bank Building, Pittsburgh, has issued a folder entitled "Insulate With Safety at Any Temperature." It emphasizes the importance of the selection of the proper refractory as well as the proper insulating material for any insulated furnace construction and describes both insulating brick and light weight brick and their applications.

Motor

The Louis Allis Company, Milwaukee, has prepared an unusual motor price wheel consisting of two fibre discs about eight inches in diameter printed in attractive colors, which quickly and accurately tells the frame sizes and list prices of 448 sizes and types of electric motors. Sent free if requested on company letterhead.

Filtration

Carl Schleicher & Schull Company, 167 East 33rd Street, New York, has published a second and enlarged edition of "Filtrations in Chemical Laboratories," a handbook on filtering operations for the chemist, including an appendix on large scale production filtrations in manufacturing plants.

Gas Mask

Mine Safety Appliance Company, Pittsburgh, has a new bulletin describing its Burrell all service gas mask which affords sure protection against carbon monoxide and other poisonous gases where there is sufficient oxygen present to sustain life.

Mixers

Mixing Equipment Company, Rochester, N. Y., has issued a new bulletin on its line of Lightnin' Mixers and Agitators. Bulletin includes illustrations and engineering data on the line of portable electric mixers, and the angular off-center propeller type agitator, and geared drive installations, as well as the concern's special applications.

Motors

Allis-Chalmers Manufacturing Company, Milwaukee, is distributing leaflet 2182 descriptive of its new seal-clad induction motors, with protected windings, which are built in ranges up to 25 horsepower, 1800 r.p.m., and furnished with either ball or sleeve bearings.

Oxygen Bomb Calorimeter

Parr Instrument Company, Moline, Illinois, has prepared Bulletin 114, a compact 42-page booklet giving detailed instructions for the correct use of this company's calorimeter in determining thermal values of coal, coke, oils, foodstuffs, and combustible material of every type.

Scale

Toledo Scale Company, Toledo, Ohio, has issued a bulletin giving information about its improved type of floor scale, including data on ten important features and explaining their service value.

Tubing Weights

Timken Steel & Tube Company, Canton, Ohio, has issued a master weight table of round steel tubing giving weights in lineal feet for all sizes of hot-finished and cold-drawn tubing from 1/16 to 10¾ inches and wall thickness from 36 B.W.G. to 1⅝ inches.

Boiler Plate

Lukens Steel Company, Coatesville, Pa., has issued a pamphlet presenting specifications for chrome-manganese-silicon alloy steel boiler plate, as set forth by the American Society of Mechanical Engineers. These specifications cover this company's Cromansil steel plates.

Alloy Castings

Michiana Products Corporation, Michigan City, Indiana, has published an illustrated booklet on its line of heat and corrosion resistant alloy castings. Text includes general classification of materials and includes photographs showing castings for machinery and corrosion resistant parts.

Conical Mills

Hardinge Company, York, Pa., has issued bulletin 13c, which is essentially a treatise on grinding. It contains valuable information on ball mills, pebble mills, open versus closed grinding, wet and dry classification, the application of air classifiers for dry grinding mills. Operating data, both specific and general feature this bulletin and it also carries capacity and dimension tables.

Heating Equipment

National Raditaor Company, Johnstown, Pa., has published a folder illustrating and describing its steam heating furnaces, cast iron convectors and tube-type radiators.

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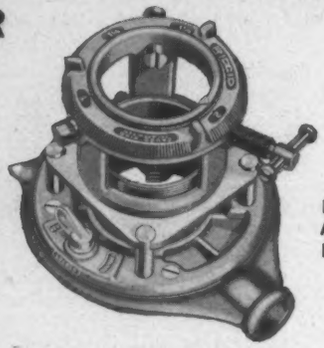

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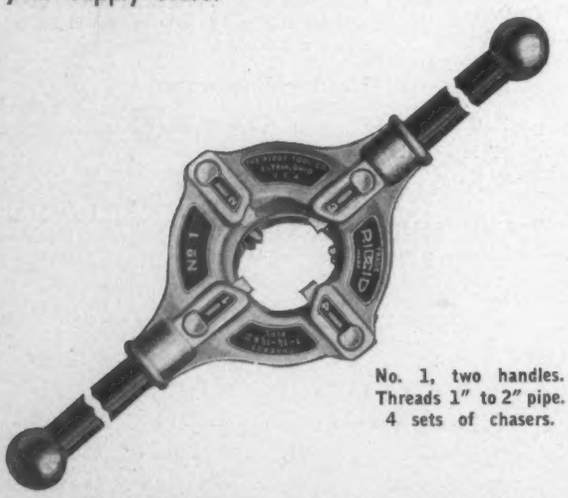
Perfected details all through—chaser locks enclosed, safe from damage; ratchet lever snaps into exact position, ratchet type also sets for solid die; workholder sets to size mechanically, tightens on pipe with one screw; alloy tool steel chasers are interchangeable, fit any poster threader; tool weighs only 12 lbs. but it's powerful. Ask your Supply Store.



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PIPE TOOLS

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